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Science and Freedom

In the 325 years since the ordeal of Galileo the physical sciences have been emancipated from political and ecclesiastical domination and, as the globe-encircling sputniks testify, can thrive even in the shadow of the State's adoption of dialectical materialism as its official philosophy. The life sciences, a century since Darwin, still stand embroiled, still struggle for the necessary freedom to grow untrammelled by common prejudice and official disfavor. Yet in the end all science must stand free or become the slave of the State, the prostitute of material desires. For scientists there can, therefore, be no greater dedication than to the defense of their freedom of thought and of choice of investigation.

The Congress for Cultural Freedom in a conference in Hamburg in 1953 undertook to arouse men to the defense of scientific freedom. That effort has been continued since 1953 through the untiring work of the International Committee on Science and Freedom, of which Michael Polanyi is chairman. This committee has published to date nine bulletins, of which the last three deal respectively with "Self-government in Modern British Universities," "Hungary, October, 1956," and "Apartheid, the Threat to South Africa's Universities." Each of these is engrossing reading.

The academic freedom of the universities of the Western World and the freedom of science are inextricably interwoven. In fact, the latter may be considered a very branch of the former. No scientist can really afford to be unconcerned with threats to the academic freedom of any university, whether in his own land or abroad.

The Nazi doctrines of racial superiority are not dead. In one semblance or another they rear themselves wherever men of one dominant social group fear themselves threatened by the numbers and growing enlightenment of a racially different element. Apartheid preaches very plausibly the theory of the equal but separate development of white and nonwhite people in residence, in labor, in education. Yet it is plain to see that actually it is a barefaced effort of the whites to keep the black and colored people of South Africa in servitude and educational inequality. Education will not be entrusted to the natives themselves to develop in independence, but will be gently governed for them by a (white) Minister of Native Affairs, whose viewpoint is sufficiently expressed in his own words: "What is the use of teaching the Bantu child mathematics when it cannot use it in practice? That is quite absurd. . . . Education must train and teach people in accordance with their opportunities in life, according to the sphere in which they live. . . . Good racial relations cannot exist when the education is given under the control of people who create wrong expectations on the part of the Native himself, expectations which clash with the possibilities in this country."

The immediate threat is the exclusion, from the five "open universities" which now admit them, of all nonwhite students, under a Separate University Education Bill which will probably be passed early in 1958. Can there be any question that in the long run the freedom of mankind—and the freedom of science along with it—is more imperiled by the defeats of Little Rock and Pretoria than by the success of sputnik?—BENTLEY GLASS.

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International Cooperation in Marine Sciences

Roger Revelle

World-wide cooperation among astronomers, meteorologists, and other geophysicists has long been taken for granted. For generations, in peace and war, astronomers have freely communicated their observations across national boundaries, and the international meteorological network has functioned continuously except under conditions of actual war. Such cooperation has lagged in studies of the ocean because of the lack of economic necessity, because of the wide differences in the level of development of marine sciences in different countries and different oceanic regions, and because of the great diversity of the scientific disciplines involved. Yet, like the atmosphere, the ocean cannot be separated into isolated parts; what happens in any part of the sea ultimately affects the waters everywhere. With the scientific resources that are now available, no one country can find out all it needs to know about the oceans except through the cooperative activity of many countries.

Although no part of the oceans has been well described, in certain areas our information is completely inadequate. Very little is known about the inshore waters off the coasts of the Indian Ocean, the east coast of Asia south of latitude 25°N, or the east and west coasts of South America. For any rational development of marine resources, simple but systematic observations are needed in all these coastal regions.

The Indian Ocean is the deep-sea area in which the deficiency of descriptive information is greatest. It is almost completely unexplored, from the scientific point of view. Not much more is known about the South Pacific. Knowledge of the South Atlantic is somewhat better, but more exploration is needed there, as well as in the Arctic Ocean and in the equatorial regions of both the Atlantic and Pacific.

In contrast to the need for elementary description in large oceanic areas, the most advanced methods and ideas of modern mathematics, physics, chemistry, and biology can be employed in studying some aspects of the marine sciences, with remarkable effectiveness. Development of these sciences throughout the world depends, in part, on enlisting the interest of workers in the basic sciences from many different countries in the problems of oceanic research.

On a regional basis, international cooperation in the marine sciences began some fifty years ago, when the countries bordering on the North Sea and the eastern North Atlantic formed the International Council for the Exploration of the Sea. Later the International Association of Physical Oceanography and the International Hydrographic Bureau began to deal with certain aspects of the subject —namely, the movements and properties of sea water and the problems of ocean surveys for navigational purposes. In more recent years, a series of international fisheries commissions has been established. These commissions have initiated cooperative research programs on the biological and environmental factors affecting a particular fishery or a particular part of the ocean. Such regional international organizations as the Pacific Science Association and the Pan American Institute of Geography and History have standing committees that compile and assimilate reports of oceanographic activities and arrange for exchanges of information. But, until the last two years, there has been no organization concerned with all the marine sciences on a world-wide basis, either from the standpoint of the fostering and coordinating of observations or from that of communication between workers in the different sciences of the sea.

The first world-wide attempt to make coordinated scientific observations in all the oceans is being carried out during the International Geophysical Year. Some seventy ships are taking part in an internationally planned program of observations, and many new shore stations are being operated, particularly on oceanic islands, to supplement the previously existing network of observatories.

The United Nations Educational, Scientific, and Cultural Organization, in its natural sciences program, has recently begun to place emphasis on the international development of the sciences of the sea, especially in regions where there has been little emphasis in the past. To guide this work, which is being carried out in cooperation with the Food and Agriculture Organization of the United Nations, UNESCO has established an International Advisory Committee on Marine Sciences. At the same time, the International Council of Scientific Unions, having in mind the successful planning of the IGY program, has established a Special Committee on Oceanic Research, with responsibility for developing an international cooperative program of fundamental research. Each of these committees has now had a formal meeting, and possibilities for the future have been to some extent clarified.

UNESCO's Marine Science Program

UNESCO's nine-man International Advisory Committee on Marine Sciences met in Lima, Peru, in October 1956 under the chairmanship of G. E. R. Deacon, director of the National Institute of Oceanography, near Godalming, England. Other members of the committee, selected to represent different regions and different marine science disciplines, are D. V. Bal (India); Anton F. Bruun (Denmark); Marc Eyries (France); Koji Hidaka (Japan); Luis Howell-Rivero (Cuba); R. Revelle (United States); D. J. Rochford (Aus-

Dr. Revelle is director of the Scripps Institution of Oceanography, University of California, La Jolla.

tralia); and Lev Zenkevitch (U.S.S.R.). Each member serves for three years. The meeting in Lima was preceded by a meeting of an interim committee, with virtually the same members, in Tokyo in October 1955.

The amount of funds available to UNESCO for promotion of scientific research is not comparable to the expenditure of any major country for this purpose. Consequently, its activities in the sciences must be very largely confined to the planning of international action, facilitation of the making of contacts among scientists of different countries, and exchange of ideas and information.

In accordance with the advice of the International Advisory Committee, the principal objective of UNESCO's marine sciences program is to encourage development of these sciences in regions where little is known about the oceans or the organisms that they contain and where there is economic and social need for increasing the harvest of food from the sea. Up to the present, UNESCO has taken steps toward the realization of this objective by providing (i) fellowships for advanced training of scientists from these regions at major centers of marine research; (ii) intensive training programs, lasting from a few weeks to a few months, for technicians and field workers within such a region; (iii) intraregional conferences that give local scientists opportunities to discuss their common problems; (iv) international symposia, conducted by scientists of wide reputation on general topics in the marine sciences, in countries or regions where these sciences have been little developed; and (v) funds to make possible the joint planning of cooperative observational programs. A modest start has been made in all these directions.

During 1956–57, grants were made for eight fellowships for advanced training, to Hong Kong, Japan, Mexico, Thailand, Argentina, Brazil, India, and the Philippines, respectively. A three-weeks' course in marine biology and taxonomy was held early in 1957 at the Oceanographic Institute at Nhatrang, Vietnam, and a course in research methods in marine biology and physical oceanography was given in São Paulo, Brazil, in 1955. Three meetings of South American marine biologists have been held; the meeting at Lima followed the third such conference, at the marine biology station of the University of Chile at Viña del Mar.

A Western Pacific oceanographic conference was held in Tokyo before the preliminary meeting of the interim committee, in 1955, and a symposium on problems in physical oceanography and biology in the Eastern Pacific, attended by scientists from the United States, Mexico, Peru, Chile, Brazil, Uruguay, and Argentina, in addition to members of the International Advisory Committee, was held prior to the Lima meeting. Travel funds have been provided to enable scientists from Australia, New Zealand, and New Caledonia to consult together concerning a joint study of the circulation of the Southeast Pacific Ocean and Tasman Sea.

The symposium at Lima centered around one of the most remarkable phenomena in the oceans, the Peru Current (the name applied to the north-flowing current along the west coast of South America). As is true of all currents along the eastern boundaries of oceans, this current is shallow, broad, and slow. But its waters are among the most productive on earth. It has been estimated that the guano birds of Peru annually harvest some 2½ million tons of pelagic fish, about 10 percent of the total annual catch of all the world's fisheries. This extraordinarily high fertility depends upon the upwelling of cold, nutrient-rich waters from intermediate depths, and these vertical movements are reflected also in tongues of comparatively cold water extending parallel to the coast. Because it depends upon the speed and direction of the southerly and southeasterly winds, upwelling off the coast of South America is an intermittent and highly variable process.

One of the striking facts brought out at the symposium was the considerable degree of asymmetry between the Peru Current and the corresponding California Current off the west coast of North America. As one looks northward toward the equator, from off the coast of Peru, the coastline trends northwestward, while off the coast of California and Mexico, as one looks southward, the coastline trends southeastward. In the comparatively low latitudes of Peru, the southeasterly trades blow nearly parallel to the coast and are much more intense than the winds to the south. This intensification of the winds accelerates the northwestward flow of the surface waters; consequently, vertical upward motion of the waters from mid-depths takes place on a large scale. Shifts in the wind system are apparently responsible for variations in the southgoing inshore countercurrent and in extreme cases produce the catastrophic series of atmospheric and oceanic events known as "El Niño" (because they occur at Christmas)—severe rainstorms and floods on land and mass mortalities of marine birds and fishes.

This model of the Peru Current and the associated inshore countercurrent is based on tenuous oceanographic observations, and it was clear from the discussions of the symposium that series of measurements very much more complete in time and area are required before a more satisfactory picture can be obtained. A new start is being made toward obtaining the necessary measurements through the recently organized Council for Hydrobiological Investigations of the Peruvian Government.

One of the most important proposals made by the International Advisory Committee has been that an international oceanographic ship should be commissioned and operated, either by UNESCO itself, under contract, or by a group of countries in accordance with the pattern for international operation of research facilities set by CERN (Comité Européen de Recherche Nucléaire). This ship would be used primarily in such a little-known area as the Indian Ocean and could serve both for obtaining scientific information and as a training ship for younger scientists in the bordering countries.

Members of the committee have advised against the establishment, in areas where the marine sciences have been little developed, of international laboratories supported with funds from governments of neighboring countries. But they have stated that new laboratories, endowed by foundations or other private sources (in order to give stability and ensure freedom for research), would be of great value. Marine biology might be emphasized at first, with expansion later into other fields as additional funds become available.

Financial Support

Financial support from UNESCO for scientific work in underdeveloped countries can be obtained in several ways. Under the technical assistance program of the United Nations, funds contributed by many different countries are used to support projects of direct economic benefit requested by the country in which the work is to be done. The Technical Assistance Board of the United Nations decides on the total yearly allocation for each beneficiary country and on the total amount of funds to be handled yearly by each operating agency (UNESCO, Food and Agriculture Organization, World Health Organization, and so on). In 1956, about $1 million was allocated to the Natural Sciences Department of UNESCO. Because the programs are established separately by the various countries that receive assistance, the technical assistance funds cannot be used as a means of developing an internationally coordinated scientific research program. They can be used to send experts, to provide 3- to 12-month fellowships, and to purchase equipment.

UNESCO, through the regular budget established every two years by its General Conference, can assist member states in carrying out educational, scientific, or

cultural projects regardless of their immediate economic repercussion. Requests are submitted by the member states, but there is no priority allocation to the different countries, and the entire program is concentrated in particular fields of science or technology. During 1955–56 UNESCO spent about $100,000 for aid to member states for projects in natural sciences.

In both the technical assistance and the aid-to-member-states programs, the national commissions, advised by the UNESCO Science Cooperation Offices, play an important role in framing and choosing projects. Funds for regional conferences and training programs are provided from the budget of the Science Cooperation Offices.

In addition to the fellowships provided under technical assistance or aid-to-member-states activities, fellowships, generally for 12 months, are granted under the exchange-of-persons program of UNESCO. The number of fellowships for each particular field of activity is decided by UNESCO's General Conference, on the proposal of the director general.

In the field of research, small sums are assigned in the UNESCO budget to specific scientific programs (such as arid-zone and humid-tropics research and marine sciences). Part of these funds are used by UNESCO for research contracts with appropriate scientific institutions to encourage investigations of international scope. The total marine-sciences budget, however, is only $31,770 for 1957 and $22,170 for 1958, and only a small part of this sum is available for research contracts. This year the Geophysical Institute of Bergen, Norway, is being given financial assistance in order that it may participate in a multiple-ship current-measuring operation in the North Atlantic Ocean, to be undertaken jointly with the National Institute of Oceanography (United Kingdom) and the Woods Hole Oceanographic Institution (United States).

Subventions are granted by the General Conference of UNESCO to international scientific organizations for the support of international meetings, publications, and the planning of international activities. For example, the International Council of Scientific Unions received $360,000 in 1955–56 (out of a total of $448,000 granted to all international scientific organizations). The initial expenses of the Special Committee on Oceanic Research were paid from this subvention to the International Council of Scientific Unions.

The UNESCO marine sciences program has also directly supported certain advanced symposia organized by scientific bodies. The recent symposium in Bergen, Norway, held under the auspices of the International Council for the Exploration of the Sea, on the measurement of primary productivity in the sea, and the symposium on the circulation of the deep waters of the ocean, held at the meeting of the International Association of Physical Oceanography in Toronto, Ontario, in September 1957, were both partly financed by UNESCO.

A third area of activity has been that of furnishing scientific assistance to other United Nations organizations; for example, a report on sea and oceanic disposal of atomic wastes has been prepared, under the supervision of H. Charnock of the National Institute of Oceanography (United Kingdom), for the United Nations Scientific Committee on the Effects of Atomic Radiation. A report on scientific considerations related to the continental shelf has been completed by an international group of experts for use in the forthcoming United Nations conference on the Law of the Sea.

UNESCO, because of its broad educational and scientific responsibilities, can draw the attention of the governments of its member states to the importance of marine research without overemphasizing the prospects of immediate useful results. It can stress the longer-range possibilities and the value of the marine sciences as a means of introducing science for its own sake.

For example, at the Tokyo meeting, the interim committee recommended that in certain developed countries, such as Japan, Australia, the countries of Europe, and India, establishment of new national centers for fundamental research on the high seas, at least partly supported with government funds, would be highly desirable. Experience in Great Britain and North America shows that in such laboratories a diversity of disciplines should be represented, including applied mathematics, theoretical and experimental physics and geophysics, chemistry (geochemistry, biochemistry, and analytical chemistry), geology, meteorology, and biology (both experimental biology and natural history). A certain "critical mass" is essential—the scientific staff should number at least ten and preferably more, and these scientists must have adequate support in facilities and technically trained assistance. The research center should have an intimate relationship with one or more universities.

Finally, UNESCO, as an intergovernmental organization, can, by various means, encourage the member states to maintain policies favorable to international scientific work on the oceans. Examples are the facilitating of exchange of scientists between research vessels and laboratories of different countries in the face of political difficulties, the relaxing of customs regulations and of other barriers to the exchange of scientific instruments for use in international cooperative marine investigations, and the maintaining of freedom of scientific research on the continental shelf and offshore waters. Since 1949, the International Law Commission of the United Nations has been engaged in a study of the regimes of the high seas and territorial waters. An international conference of plenipotentiaries to examine the Law of the Sea has been called by the General Assembly of the United Nations, to be held in 1958. UNESCO's International Advisory Committee on Marine Sciences, although recognizing that each country has a right to protect its coastal waters from economic exploitation, and that there are also certain military considerations, has urged that there should be no restriction on scientific studies by research vessels of any nation, provided that the results are published and the work itself is open to exchange of scientists. This viewpoint has been supported by UNESCO's Advisory Committee on Research in the Natural Sciences. In April 1957 the latter committee adopted a resolution urging the director general of UNESCO "to present the International Conference on the Law of the Sea with proposals ensuring freedom of fundamental research on waters, sea bed and subsoil of the continental shelf carried out by any nation with open publication in the interest of all." This committee has further expressed serious concern about the possible consequences of Article 68 of the draft Articles of the Law of the Sea prepared by the International Law Commission, "which in its present form does not guarantee the freedom of scientific research on the physical characteristics, geology and biology of the sea bed and subsoil of the continental shelf."

Special Committee on Oceanic Research

The Special Committee on Oceanic Research of the International Council of Scientific Unions consists of 15 members. Six members were nominated by the International Council of Scientific Unions, four by the International Union of Geodesy and Geophysics, two by the International Union of Biological Sciences, and one each by the International Union of Pure and Applied Physics, the International Union of Pure and Applied Chemistry, and the International Geographical Union. This committee held its first meeting at the Woods Hole Oceanographic Institution from 28 to 30 Aug. 1957, under the chairmanship of director C. O'D. Iselin. Other members present at the meeting were A. F. Bruun (Denmark); G. Bohnecke (Germany);

L. R. A. Capurro (Argentina); G. E. R. Deacon (United Kingdom); M. N. Hill United Kingdom); N. B. Marshall (United Kingdom); Y. Miyake (Japan); H. Mosby (Norway); N. W. Rakestraw (United States); R. Revelle (United States); E. Steeman Nielsen (Denmark); and L. Zenkevitch (U.S.S.R.). Y. Le Grand of France and N. K. Pannikar of India were unable to attend.

The committee took as its first task that of defining the needs for further international scientific cooperation in the marine sciences. It is clear that, as in other sciences, a very large part of the pioneering research and new ideas concerning the oceans must come from individual scientists or small groups working independently. A broadly based international organization can be helpful, however, in several ways. It can serve as a sounding board to emphasize the economic and social importance of greater knowledge of the oceans and can thereby assist marine scientists in different countries to obtain support for their work. By arranging wide dissemination of ship operating schedules, it can help scientists to participate in cruises or to obtain desired data and collections. By pointing out areas where work is needed and the kinds of observations that should be made, it can encourage more efficient use of research vessels. It can facilitate the exchange of techniques, personnel, samples, and data. By sponsoring or encouraging discussions of problems of ocean research at national and international scientific meetings, it can help enlist scientists from other fields. It can arrange for coordinated work, by research vessels at sea and by shore observatories of different countries, in attacking problems where a wide network of observations is needed. It can serve as a mechanism for the standardization and intercalibration of techniques and instruments and can arrange for the introduction of techniques newly developed in one country or laboratory to other scientific groups elsewhere in the world.

The committee considered that its principal objective should be to encourage and coordinate an international program of observation and measurement in the deep ocean. One point of this program would involve an intensive effort to understand the relationships between the dynamics of the upper water layers and the plant and animal populations. Another would be the study of the region from below the thermocline down to the greatest depths of the sea and beneath the sea floor. Because so little is known about this region, its investigation will be, to a large extent, a task of widespread exploration. Such exploration must proceed hand-in-hand with theoretical studies and development of new techniques by individual scientists and must supplement rather than interfere with their work.

In making a decision to concentrate its program in the deep oceanic regions, the committee recognized that geophysical and geological studies of the earth beneath the sea are necessary for elucidating the structure and history of the earth. With regard to the waters and the organisms that they contain, it emphasized three long-range problems that may be critical to the future welfare of mankind.

Long-Range Problems

The first of the long-range problems concerns the use of the deep sea as a receptacle for the waste products of our industrial civilization. This may be a particularly important problem in the future, when very large quantities of poisonous radioactive wastes will be produced through the industrial use of atomic power. We need to know whether we can dispose of at least part of these wastes in the deep sea or whether the circulation of the ocean or the vertical movements of the fauna will result in a rapid transport of dangerous material to levels in the sea from which some of the world's food supplies are derived.

The second problem concerns the oceans as an important source of protein food for many of the world's peoples. With the growth of populations, man's need for food from the sea may be expected to increase rapidly. The living resources of the oceans are by no means infinite, and, like the land, the oceans differ widely in fertility in different parts. The fertile areas are those where nutrient trace substances, essential for plant life, are brought up from the deep waters. To obtain the maximum harvest, the processes by which this occurs must be elucidated.

The third problem is perhaps the least well understood of the three. It concerns the role of the oceans in climatic change. During the last 50 years the average temperature over eastern North America and northern Europe has increased markedly, while elsewhere prolonged droughts have destroyed the work of decades. Will this trend continue over the next 50 years, or will it be reversed? Because we do not have sufficient understanding of the processes that control climate, we are quite unable to make a forecast. Nevertheless, a prediction of future climate would be of inestimable value to society.

The waters of the oceans may play an important role in changing climates. For example, an excess of heat from the sun can be stored in the deep water and slowly released over many years, warming the air. Likewise, the amount of carbon dioxide in the air controls, at least to some extent, the average air temperature and the loss of heat from the earth. Any change in atmospheric carbon dioxide—for example, by addition from fossil fuel combustion—may be damped or modified by the absorption of carbon dioxide in the ocean waters.

New Techniques

For an understanding of each of these three problems, greater knowledge of the rate and character of the exchange between the deep and surface waters of the oceans is required. It is only within the last few years that we have been able to make an effective attempt to gain such knowledge, through theoretical analysis of the thermodynamics and hydrodynamics of the oceans, through laboratory and field experimentation, and through the development and field use of new techniques.

Among these new techniques are: (i) the use of radioactive substances that occur naturally in the water, such as radiocarbon and tritium, for tracing the paths of motion and the mixing of the waters; (ii) the making of direct measurements of the deep currents by using deep current meters or by following free-floating, neutrally buoyant buoys (for these it is necessary to maintain a fixed reference position; this can now be achieved by tautly anchoring a subsurface buoy to the sea bottom); (iii) the measurement, with a new degree of precision, of the salt content of the water and the tracing of the water movements by means of these data on salt content; (iv) the measurement of the heat flow from the interior of the earth into the deep water and use of data on the heating of the water as an index of the time of passage of the water over the bottom; (v) the possible introduction of relatively large amounts of artificially radioactive substances, of the order of tens of thousands of curies or more, into deep ocean areas and the measurement of the dispersion and transport of this material by the deep currents; (vi) detailed biological, chemical, and physical studies of the variations in the sediments of the deep-sea floor as a means of deciphering past changes in the water conditions; and (vii) utilization of new methods of high precision for determining carbon dioxide content in the water and the air.

Five-Year Program of Deep-Sea Research

Deep-sea exploration, because it involves the use of relatively large and heavily equipped ships for long periods, is the most expensive kind of oceanic research. An adequate program of exploration is beyond the resources of any one

country. Moreover, the total cost will be minimized through planned international cooperation in the use of ships and facilities.

For the first two or three years the principal effort will be devoted to exchange and standardization of techniques, collection of samples for analysis and study by different laboratories, and exchange of data that can serve to guide further exploration. During this stage of development, effort will necessarily be concentrated in the North and South Atlantic and in the North and South Pacific oceans.

With adequate preparation during the first years, it should be possible, during the third or fourth years (provided that adequate funds and ships are made available), to make a combined assault on the largest unexplored area on earth, the Indian Ocean. This area is of special interest to physical oceanographers because seasonal reversals in wind direction that are not known elsewhere provide opportunity for studying the transient state in the wind-driven currents. Few scientific vessels have ever visited the Indian Ocean, and almost none of the new techniques have been applied there.

It would be anticipated that, in addition to scientists from the Northern Hemisphere, scientists and students from the countries bordering on the Indian Ocean would take part in this series of simultaneous expeditions. The expeditions would thus not only serve their primary purpose of exploration but would also have a lasting effect in encouraging and developing the marine sciences and fisheries in those countries.

It is estimated that at least 16 ships from 11 different countries could be enlisted. Each research vessel would spend approximately eight months at sea. The combined scientific party on all the ships would total about 125 persons; at least 25 of these might come from countries bordering on the Indian Ocean area, and it would be desirable to give many of the latter a year's prior training in centers of advanced oceanic research. At least 100 scientist-years would be required for working up the results.

During subsequent years, when the present extreme difficulties of making measurements at depths of several thousand meters and of obtaining accurate positions on the high seas have been sufficiently overcome, a tracer experiment, in which a large quantity of artificially radioactive material would be used, should be undertaken in some suitable deep-sea area. This will involve very careful international planning and coordination.

Organization and Budget

The Special Committee on Oceanic Research has set up five working groups, each consisting of five to seven active research workers in a particular field. These groups, with their conveners, are as follows: (i) group on the measurement of artificial radioactivity (Y. Miyake, Japan); (ii) group on the measurement of carbon dioxide in the air and the sea and its exchange rate (N. W. Rakestraw, United States); (iii) group on the measurement of standing crops of phytoplankton and zooplankton and the productivity of the sea (N. B. Marshall, United Kingdom); (iv) group on the measurement of the physical properties of sea water (H. Mosby, Norway); (v) group on exploration of the Indian Ocean (C. O'D. Iselin, United States).

Revelle, Deacon, and Bohnecke were nominated as chairman, vice chairman, and secretary, respectively, of the Special Committee on Oceanic Research. They will function as an executive committee responsible for the detailed administration of the committee's operations. Iselin and Zenkevitch were nominated as members of the finance committee to prepare the budget. These nominations have been confirmed by the International Council of Scientific Unions.

A program of international cooperation in deep-sea research cannot be carried out successfully without the enthusiastic support of existing international marine science organizations. Every effort will be made to utilize their facilities and procedures.

In organizing its scientific program, the Special Committee on Oceanic Research will also invite the cooperation of qualified academies or research councils of different countries, and each participating organization will be requested to designate a corresponding member to the Special Committee.

The total expenditures for the proposed year-long program of exploration of the Indian Ocean would be about $4 million, largely for ship costs. Half of this amount could come from the normal operating funds for ships and marine research laboratories of the participating countries, but additional sums totaling approximately $2 million must be raised. The Special Committee itself will need funds to establish a secretariat to maintain a flow of information about new methods, designs of instruments, and plans among the different countries; to pay for meetings of working groups of specialists who are developing and standardizing new techniques or planning expeditions; to make possible the transfer of key scientific personnel to the laboratories and ships where they can give training in, or learn from others, the use of specialized techniques and methods—for example, the seismic refraction methods of studying suboceanic structure that have been so successfully developed in the United States and England. An estimated annual budget of $45,500 a year for the next five years would cover these costs.

Note

This article is contribution No. 966, New Series, from the Scripps Institution of Oceanography.

Lamont Natural Radiocarbon Measurements IV

W. S. Broecker and J. L. Kulp

The carbon-14 age determinations made at the Lamont Geological Observatory during the period from October 1955 to March 1957 are reported in this article (*1*). These measurements were all made by the CO_2 gas proportional counting method described in detail elsewhere (*2*). A statement of the method of computing the laboratory error was given in the preceding date list (*3*).

The results are presented in Tables 1 through 4. Table 1 summarizes the measurements of geologic interest. A number of the dates bear on the problem of fluctuations in sea level. Information concerning the more general problem of the duration of the last period of low sea level is provided by the samples from the Mississippi delta, Bermuda, and Santa Rosa Island, while measurements on materials from the Bahamas provide more specific information concerning post-Wisconsin sea levels.

Table 2 contains age data on a wide variety of archeological materials. One of the more interesting measurements of this type has been included in Table 1 because of its importance to the over-all picture of the evolution of the alluvial fans on Santa Rosa Island. This sample (L-290R) also provides evidence about ancient man in America. The date of 29,700 years on burned elephant bone suggests that man occupied the west coast of North America before the major ice advance of the latter part of the Wisconsin glacial period.

Tables 1 and 2 include a number of samples run by different methods and laboratories. Samples L-190A, L-217A, L-217B, L-335H, and L-335I are in good agreement with results published by the U.S. Geological Survey laboratory on identical samples (*4*). In one case, however (sample L-177), the difference was outside the reported laboratory error. Whereas the majority of rechecks on dates obtained by the black carbon method substantiated the earlier results (see samples L-331A, L-331B, L-331C, L-283G, L-311, and L-336A), a few published ages were found to be too young, presumably because of contamination of the samples by air-borne fission products (see samples L-120G and L-120F). Other checks where both laboratories used a gas-counting technique showed agreement in two cases (samples L-358A, which was also dated by the Humble Oil Company laboratory, and L296A, a tree-ring standard circulated by the Stockholm laboratory).

Tables 3 and 4 include samples from ocean-bottom cores and pluvial lake deposits. Ocean-bottom cores and pluvial lake deposits have been studied intensively at Lamont because of their importance in reconstructing late Pleistocene chronology. The implications of the results on ocean cores in terms of climatic change have been published (*5*) and a summary of the data concerning sedimentation rates is in preparation (*6*). The cores studied were all from the Lamont collection. Maurice Ewing and B. C. Heezen were responsible for the collection of most of these cores, and D. B. Ericson was responsible for the micropaleontologic and lithologic studies (*7*).

Table 4 gives the results obtained from samples selected to provide detailed information concerning the fluctuations in the level of the dry and nearly dry lakes in the Great Basin (*8*). Since these ages were obtained mainly on fresh water carbonates, two criticisms that have been leveled at such materials must be considered. The first is the problem of the initial carbon-14 concentration in the carbonate. As shown by Deevey (*9*), such materials can be low in carbon-14, presumably because of the incorporation of carbonate leached from ancient sedimentary rocks. Measurements on contemporary carbonates and algae from Pyramid Lake indicate that the dissolved carbonate in the lake is only 5 percent lower than the maximum or static equilibrium value. Although it cannot be demonstrated rigorously, there is fairly good evidence to indicate that the variation of the C^{14}/C^{12} ratio during times of high lake level was probably less than 5 percent. The errors introduced by this source are hence probably less than 500 years (*10*).

A second possible source of error in carbonate samples is that of postdepositional exchange of the carbonate ions in the sample with those in its surroundings. In order to make a quantitative estimate of the extent of such contamination, we have studied the problem both by laboratory experiments on natural carbonates and by theoretical calculation, using data on the diffusion rate and surface area. Both methods lead to the conclusion that the amounts of contamination from this source are less than the equivalent of the addition of 2 percent of modern carbon dioxide (*10*). Since the majority of the samples measured are less than 20,000 years in age, the error introduced in most cases is much less than 500 years. If such contamination were present, the ages given in Table 3 would in all cases be minimal.

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Table 1. Radiocarbon dates of geologic samples.

Description	Sample No.	Age (yr)
Juneau, Alaska. Muskeg sample of basal sedge peat in the early pine pollen zone at a depth of 3.8 m. The locality is 3 mi from the end of Montana Creek road northwest of Juneau. The age of the peat should reveal the time of earliest pollen sedimentation in the region and should just postdate the recession of the late-Wisconsin ice. Submitted by C. J. Heusser, American Geographical Society.	L-297D	10,300 ± 400
Fletcher's Ice Island, T-3. Samples of organic muck forming layers within the ice. The layers were presumably formed by concentration during melting of the ice. These samples are from the Silk Hill area and were collected during August 1955. Submitted by Norman Goldstein, Air Force Cambridge Research Center.		
Surface dirt.	L-298A	3750 ± 200
Dirt from bottom layer.	L-298B	3400 ± 250

Description	Sample No.	Age (yr)
St. Pierre les Becquets section, Québec. Wood from a 2-ft layer of compressed peat in nonglacial alluvial sediments that occur 75 ft below the surface in a section comprising 3.5 ft of alluvial sand, 5.0 ft of marine silt, 66.5 ft of proglacial varved silt and clay, 1.5 ft of nonglacial alluvial sand, 2.0 ft of compressed peat and wood, 3.25 ft of silty alluvial sand with some organic matter, 0.5 ft of compressed peat and wood, 1.5 ft of coarse alluvial sand, 1.25 ft of compressed peat with some wood, and 2.0 ft of coarse alluvial sand. The nonglacial sands and peat are underlain in nearby sections by red calcareous till. The proglacial varves are overridden in other sections by gray calcareous till that represents the last ice advance into the area. The section is on the north bank of an intermittent stream, tributary to the St. Lawrence River, that crosses Provincial Highway No. 3 about 1 mi south of the village of St. Pierre les Becquets. It is on the property of Lucien Laroche in lot 4, concession I, parish of St. Pierre les Becquets, Leurard Township, Nicolet County. A similar sample from this section, dated by the U.S. Geological Survey (W-189), also gave an age of > 40,000 yr (*4*). Submitted by N. R. Gadd, Geological Survey of Canada.	L-190A	> 40,000
Port Talbot, Ontario. Gyttja from the base of a wave-cut cliff on the north shore of Lake Erie 2 mi southwest of Port Talbot. Pollen analyses indicate that a cool, hence interstadial, climate must have existed during the period of deposition (*11*). The sample is overlain by 100-ft-thick Wisconsin deposits, including four layers of till. The second till above the gyttja is the same as the till that contains samples L-185B and L-217B at Plum Point, 1 mi southwest of the gyttja exposure. Measurements by the U.S. Geological Survey (*4*) indicate that this material is greater than > 32,000 yr old. Submitted by A. Dreimanis, University of Western Ontario, who considers that the base of the gyttja corresponds to the thermal maximum of the interstadial between the early and the main Wisconsin glaciations (*12*).		
Sample No. 1.	L-185A	> 38,000
Sample No. 2.	L-217A	> 39,000
Plum Point, Ontario. Wood from the "lower till" exposed in a wave-cut cliff on the north shore of Lake Erie. Measurements on a duplicate sample of No. 1 sent to the U.S. Geological Survey gave an age of 27,500 ± 1200 yr (*4*). Submitted by A. Dreimanis, who considers that the lower till was deposited by the main Wisconsin glaciation (*12*).		
Sample No. 1, larch wood (*13*).	L-185B	28,200 ± 1500
Sample No. 2, spruce wood (*13*).	L-217B	24,600 ± 1600
Meaford, Ontario. (All levels are geodetic.) Wood sample of a cedar log from an ancient lake bed, 597.202 ft; imbedded in clay 3.5 in., 596.91 ft; overlay of sand, 605.41 ft; location about 2000 ft from ancient river mouth; taken from public utilities basement excavation on 21 Sept. 1955; lake level then probably about 651 ft; present lake level, 579.8 ft; length of log, 7.25 ft, diameter, 0.75 ft; well-preserved; elevation indicates old Lake Nipissing period (subsequent to Lake Algonquin). Submitted by F. Stanley Knight, Meaford, Ont.	L-312	6300 ± 150
Queen Charlotte Islands, British Columbia. Sample of limnic peat at a depth of 6.6 m in muskeg on Langara Island. Pollen profiles reveal a very early postglacial record. The sample should closely date the retreat of the Cordilleran ice from the ocean border. Submitted by C. J. Heuser.	L-297C	10,850 ± 800
Fraser Lowland, British Columbia. Wood from glacial deposits presumably laid down by advancing Sumas ice, but the possibility that it was laid down by retreating Vashon ice cannot be disregarded. Since the dates obtained agree quite well with those from Two Creeks, it is concluded that these deposits are of Valders age. The dates confirm earlier measurements, by the black carbon method, on samples from this area (L-221D and L-221E) (*14*). Submitted by J. E. Armstrong, Geological Survey of Canada.		
Wood from Whatcom glaciomarine, clayey silt deposits exposed along Norrish Creek.	L-331A	11,450 ± 150
Wood from till-like Whatcom glaciomarine deposits near the mouth of Norrish Creek.	L-331B	11,700 ± 150
Wood from Whatcom glaciomarine, stony, clayey silt along a small creek north of the monastery near Mission, B.C. The deposit is overlain by Sumas till.	L-331C	10,950 ± 200
Lake Washington, Wash. Section of wood from the base of a Douglas Fir tree standing upright on the bottom of the north end of the lake at a depth of 90 ft. The tree, 55 ft in length, including a 10-ft root zone, and 3 ft thick at the base, was pulled out of the bottom intact. The tree was presumably displaced into the lake by an ancient landslide. The purpose of the dating was to establish the date of the landslide. Submitted by H. R. Gould, University of Washington.	L-269E	1160 ± 80
Lake Washington, Wash. Limnic peat material from a core taken in the central part of the lake. The samples are from 40 ft below the lake bottom, just above a thick sequence of blue clays. The water depth is approximately 190 ft. The date should provide a minimum age for the withdrawal of the Vashon ice sheet from the Seattle area. Submitted by H. R. Gould.		
Sample No. 1.	L-330	14,000 ± 900
Sample No. 2.	L-346A	13,650 ± 550
Santa Rosa Island, Calif. These samples were collected from an alluvial fan truncated by wave action. The fan was presumably deposited during times of low sea level, when the streams flowed from the hills out across a wide wave-cut terrace (10 to 25 ft above present sea level) which probably was formed during the last interglacial period. The		

Description	Sample No.	Age (yr)
present-day streams have cut down through the fans, indicating that growth of the fans probably ceased when sea level rose sufficiently to begin the truncation of the alluvial material. The total thickness of the deposits averages about 50 ft. They are capped by fairly mature soils, sand dunes, and, in some areas, by debris from human occupation. Collected by P. C. Orr, Santa Barbara Museum of Natural History, and W. S. Broecker.		
Calcareous sand from a small dune built into the alluvium 40 ft below the surface, which corresponds to a point 80 percent of the way down through the alluvial material.	L-290Z	> 33,000
Thoroughly charred dwarf mammoth bones associated with numerous, large, uncharred pieces of bone from the same animal. The sample was located 36 ft below the top of the alluvium, which corresponds to 50 percent of the way down through the mass.	L-290R	29,700 ± 3000
Charcoal from a burned layer 9 ft below the soil which forms the surface of the alluvial fan.	L-290T	12,500 ± 250
Santa Rosa Island, Calif. Organic muck from the lower layers in a *ciénaga* (pond) deposit which once filled in an old river channel cut into the alluvial fans which were formed in the river systems during times of low sea level. The *ciénaga* itself has been recut by the river. It is now exposed on one side of the rectangular stream channel. The original alluvial material forms the other side. The cause of this filling and recutting of the channel is not clear. Collected by P. C. Orr, G. F. Carter, C. L. Hubbs, and W. S. Broecker.	L-290C	9050 ± 600
La Jolla, Calif. Giant pismo clam shell from beneath an A-B-C soil profile. The size of the clam indicates that the water was then colder than it is at present. Submitted by G. F. Carter, Johns Hopkins University, in connection with an investigation of soils.	L-299A	4400 ± 150
San Diequito River Valley, Calif. Shell from an old midden in the upper part of the fill. The sample should date the lime-pan type of midden and would set a minimum age for the valley fill and the associated developed soil profiles. Submitted by G. F. Carter.	L-299B	6680 ± 170
La Jolla, Calif. Charcoal from a hearth in a midden on top of the sand over a Pleistocene beach. Only a weak soil profile has been developed, but distinct leaching and a beginning of soil development have occurred. Submitted by G. F. Carter.	L-299C	2800 ± 150
Mississippi alluvial valley, La. These samples were taken from cores penetrating the sediments deposited by the Mississippi River during periods of rising sea level following the maximum low of the last glaciation. The trench cut by the river had a maximum depth of about 450 ft and is filled for the most part with gravel and sand below a depth of 100 ft. These deposits grade upward into silts and clays designated as the "topstratum deposits" by Fisk (*15*). A detailed description and interpretation of the deposits has been published by Fisk and McFarlan (*16*). The sample depths quoted do not necessarily correspond to sea level at the time of formation of the sample. The possibility of formation some distance above or below sea level, the possibility of redeposition after formation, and the possibility of postdepositional movement because of subsidence or uplift of the sediments must be considered. The samples were submitted at our request by H. N. Fisk and E. McFarlan, Humble Oil Co., Houston, Tex.		
Marine shells (mostly *Arca, Cardium, Mulinia, Tellina, Chione,* and echinoid fragments) from a core of fine, gray sand, 60 ft below sea level, U.S. Corps of Engineers boring No. 1-U, 300 ft west and 100 ft south of the northeast corner, sec. 2, T13S, R24E, Gretna area, Jefferson Parish, La.	L-291A	4370 ± 220
Marine shells (mostly *Crassostrea, Crepidula, Mytilus,* and *Balanus* fragments) from a core of gray, silty clay, 90 ft below sea level in the same boring as sample L-291A.	L-291B	7870 ± 170
Marine shells (mostly *Arca, Olivella, Crassinella, Anomia,* and *Chione* fragments) from a core of interbedded gray sand and gray, silty clay, 121 ft below sea level, New Orleans expressway boring No. 107, at intersection of S. Roman St. and New Basin Canal, Orleans Parish, La.	L-291C	27,000 ± 1200
Marine shells (mostly *Arca, Olivella, Nuculana,* and *Anomia* fragments) from a core of gray, clayey sand, 147 ft below sea level, New Orleans expressway boring No. 143, at intersection of St. Charles and Calliope Sts., Orleans Parish, La.	L-291D	29,300 ± 2000
Marine shells (mostly *Corbula, Nuculana, Arca, Tellina,* and echinoid fragments) from a core of gray, silty clay, 177 ft below sea level, Humble Oil and Refining Company core test 1, Louisiana state lease 799, lat. 29°09.0′N, long. 89°59.0′W, Grand Isle block 16, offshore from Jefferson Parish, La.	L-291E	7600 ± 350
Wood from a core of gray, silty clay, 218 ft below sea level, Humble Oil and Refining Company core test 1, Louisiana state lease 804, lat. 29°08.5′N, long. 89°58.9′W, Grand Isle block 16, offshore from Jefferson Parish, La.	L-291F	> 37,000
Marine shells (mostly *Chione, Arca, Nuculana, Dosinia,* and *Thais* fragments) from a core of gray, clayey sand, 215 ft below sea level, Humble Oil and Refining Company core test 1, Louisiana state lease 799, lat. 29°09.0′N, long. 89°59.0′W, Grand Isle block 16, offshore from Jefferson Parish, La.	L-291G	11,050 ± 300
Marine shells (mostly *Dosinia, Nuculana, Phacoides, Corbula,* and echinoid fragments), from bit cuttings of gray, silty clay, 233 to 243 ft below sea level, Humble Oil and Refining Company well No. E-6, Louisiana	L-291H	10,530 ± 350

Description	Sample No.	Age (yr)
state lease 797, lat. 29°10′45″N, long. 89°52′30″W, Grand Isle block 18, offshore from Jefferson Parish, La.		
Wood from bit cuttings of sand and gravel, 313 to 323 ft below sea level, in the same well as sample L-291H.	L-291I	> 40,000
Wood from a core of sand and gravel, 370 ft below sea level, Humble Oil and Refining Company core test 1, hole 2, Louisiana state lease 797, lat. 29°11′25″N, long. 89°53′00″W, Grand Isle block 18, offshore from Jefferson Parish, La.	L-291J	> 31,000
Wood from bit cuttings of gray, silty clay, 260 to 280 ft below sea level, NE¼NE¼ sec. 18, T21S, R31E, Venice area, Plaquemines Parish, La.	L-291K	17,150 ± 500
Marine shells (mostly *Corbula, Pecten, Arca, Nuculana, Anomia,* and echinoid fragments) from bit cuttings of gray, silty clay, 360 to 380 ft below sea level in the same boring as sample L-291K.	L-291L	31,850 ± 3000
Shells of brackish-water and marine fauna (mostly *Crassostrea* with a few *Thais* and *Phos* fragments) from bit cuttings of gray sand, 485 to 490 ft below sea level in the same boring as sample L-291K.	L-291M	> 36,000
Wood from bit cuttings of sand and gravel, 400 to 420 ft below sea level, 2100 ft southeast of the northwest line, 2000 ft southwest of the northeast line, sec. 53, T20S, R29E, Buras area, Plaquemines Parish, La.	L-291N	17,000 ± 500
Marine shells (mostly *Arca, Crassinella,* and *Pecten* fragments) from bit cuttings of sand and gravel, 220 to 240 ft below sea level, 200 ft south and 1000 ft west of the northeast corner, sec. 4, T21S, R22E, Bay Laurier area, Lafourche Parish, La. This sample may have been contaminated by cuttings from a higher elevation in the boring.	L-291O	8350 ± 180
Marine shells (mostly *Arca, Crassinella,* and *Pecten* fragments) from bit cuttings of sand and gravel, 320 to 340 ft below sea level in the same boring as sample L-291O. This sample may have been contaminated by cuttings from a higher elevation in the boring.	L-291P	9100 ± 210
Finely divided wood and plant fragments from bit cuttings of sand and gravel, 210 to 220 ft below sea level, Humble Oil and Refining Company well No. 1, Louisiana state lease 2258, 660 ft north of the south line, 605 ft west of the east line, sec. 35, T12S, R11E, Bayou Pigeon area, Iberia Parish, La. This sample was probably contaminated by cuttings from a higher elevation in the boring.	L-291Q	870 ± 80
Rounded and angular fragments of black wood from bit cuttings of sand and gravel, 240 to 270 ft below sea level, in the same boring as sample L-291Q.	L-291R	> 34,000
Rounded and angular fragments of brown wood from bit cuttings of sand and gravel, 270 to 300 ft below sea level, in the same boring as sample L-291Q.	L-291S	> 33,000
Brown fibrous fragments of wood from bit cuttings of sand and gravel, 260 to 380 ft below sea level, 900 ft south of the north line, 2000 ft west of the east line, sec. 37, T18S, R21E, Larose area, Lafourche Parish, La.	L-291T	25,500 ± 600
Finely divided black wood fragments from bit cuttings of sand and gravel, 200 to 220 ft below sea level, 100 ft south of the north line, 100 ft west of the east line, sec. 84, T21S, R18E, Cocodrie area, Terrebonne Parish, La.	L-291U	16,800 ± 650
Brown, angular fragments of wood from bit cuttings of sand and gravel, 325 to 340 ft below sea level, Humble Oil and Refining Company well No. T-1, Louisiana Land and Exploration Company, NE¼NE¼ sec. 4, T22S, R17E, Bay Saint Elaine area, Terrebonne Parish, La.	L-291W	> 36,000
Black, organic-rich, silty peat from bit cuttings of dark gray, silty clay, 140 to 160 ft below sea level, NW¼-NE¼ sec. 9, T20S, R17E, Dulac area, Terrebonne Parish, La.	L-291X	10,700 ± 150
Large wood fragments from a core of gray, organic-rich, silty clay underlying a natural levee of the Mississippi River, 4 ft above sea level, southwest corner, sec. 47, T11S, R6E, Reserve area, St. John the Baptist Parish, La.	L-291Y	2050 ± 150
Thais shell fragments dredged from the floor of the Gulf of Mexico at depth of about 200 ft, lat 28°12.0′N, long. 92°58.0′W, off Vermilion Parish, La. during cruise of research vessel *Vema* in the spring of 1954. The shells came from an assemblage of marine and brackish-water fauna, including oysters.	L-291Z	7210 ± 200
Marine shells (mostly *Dosinia, Arca, Pecten, Corbula,* and echinoid fragments) from A.P.I. project 51 core No. PL 244-52, in 180 ft of water; sample from the interval 8 to 15 ft below floor of the Gulf of Mexico; lat. 29°26.4′N, long. 88°08.0′W, east of the modern Mississippi delta.	L-291AA	7000 ± 200
Marine shells (mostly echinoid fragments) from a core of gray, silty clay, 570 ft below sea level, Gulf Oil Corporation well No. 3, Buras Levee district, state unit, Scott Bay, NW¼-NW¼ sec. 28, T23S, R31E, Plaquemines Parish, La. The age of this sample was previously determined by the Humble Oil Company laboratory as 21,700 ± 800 yr (*16*) and more recently as > 35,000 yr (*17*).	L-358A	> 33,000
Sea Coast, N.C. Sample from peat bed exposed only at low tide. Pollen analysis indicates a climate similar to that of the present time. Since the peat was deposited in a fresh-water swamp, it indicates a rise in sea level in this area from 5 to 10 feet in the past few hundred years. Independent evidence from tide gages and old rice fields supports the idea of a rising sea level. Submitted by S. Taber, University of South Carolina.	L-222B	< 300
Santee River, S.C. Piece of wood from a large log exposed in the excavation for an electric generator below Santee Dam across the Santee	L-222C	800 ± 130

Description	Sample No.	Age (yr)
River in Clarendon and Berkeley counties. The sample comes from a series of flood-plain deposits. Submitted by S. Taber.		
Myrtle Beach State Park, S.C. Cedar from a peat bed exposed at low tide. Pollen of spruce and fir has been found in the peat, indicating a colder climate than at present. Stratigraphic evidence indicated that this sample should postdate the last interglacial period. Submitted by S. Taber.	L-222A	> 31,000
Sussex County, N.J. Peat associated with mastodon remains found in a bog located in the Highland Lakes area. Submitted by M. E. Johnson, Department of Conservation, State of New Jersey.	L-231	10,890 ± 200
Bermuda. Sample of Southampton eolianite from Sayles' (*18*) locality No. 4, taken 3 ft 4 in. from the top of the 12-ft formation. Previously dated by the black-carbon method (*14*) as 17,600 ± 800 yr. The new measurement suggests that this earlier date, as well as the date on the underlying Somerset formation (sample L-120F) of 21,000 ± 1600 yr, is too young. Collected by P. Gast, Columbia University.	L-120G	> 30,000
Bermuda. Samples were taken from bore holes located in the vicinity of Longbird Bridge at the western extremity of Kindley Air Force Base, near the north shore of Castle Harbor in eastern Bermuda. Fauna associated with the samples are Pleistocene in age. Sample L-328 appears to have been deposited at a time when sea level was on the order of 60 or more feet higher than it is at present. Samples L-275A and L-275D are reasonably fresh samples of cedar that appear to have been overwhelmed by a rapidly rising sea level. Evidently the deposition of these materials and the eustatic changes in sea level that the materials represent did not occur during the decline of the last Wisconsin glaciation. Submitted by Walter S. Newman, Jackson Heights, N.Y.		
White to buff, angular, silty sand composed of 90 percent or more of debris of *Halimeda* sp. Located 60 ft below present sea level.	L-328	> 33,000
Mixture of charred and uncharred cedar and peaty material. The top of the upper peat is 63 ft below present sea level.	L-275A	> 37,000
Black fossiliferous peat. The lower peat is 72 to 74 ft below present sea level.	L-275B	> 37,000
Bimini, Bahamas. Mangrove peat from 9 ft below low water level. The sample, taken from a core, is overlain by about 9 ft of calcareous sand. The age on this sample is in the same range as the ages obtained on similar deposits that were found in Florida (*14*). Submitted by N. D. Newell, Columbia University.	L-366B	4370 ± 110
Bimini, Bahamas. Oolite sand from the eastern side of Brown Cay from the sediment surface at a depth of 4 to 5 ft of water. Since the C^{14} concentration in the water above the sediments has not been determined, the age was calculated using the average C^{14}/C^{12} ratio for North Atlantic surface water as a control. Submitted by N. D. Newell.	L-366I	740 ± 100
North Bimini, Bahamas. Shell taken from beach rock exposed in a low, wave-cut sea cliff. The sample was located 6 ft above the high-tide level and is thought by the collector to indicate a positive sea stand. Submitted by K. K. Turekian, Yale University.	L-321A	2300 ± 200
North Bimini, Bahamas. Cemented oolite dune sand, presumably deposited subaerially. This sample is probably a composite of older oolite and more recent cement; hence the age must be considered a minimum one. Submitted by K. K. Turekian.	L-321D	13,000 ± 500
South Bimini, Bahamas. Fossil shells separated from the rock which forms the island. Believed to predate the last period of low sea level. Submitted by K. K. Turekian.	L-321B	> 27,000

Table 2. Radiocarbon dates on archeological samples.

Description	Sample No.	Age (yr)
Vancouver, British Columbia. Hearth charcoal from a depth of 9 ft in midden refuse containing clam and mussel shell and artifacts. The site referred to as the Great Fraser midden is located on the southern limits of the city of Vancouver. The sample was associated with the remains of Mongoloid people. Submitted by T. H. Ainsworth, City Museum of Vancouver.	L-337	2100 ± 90
Santa Rosa Island, Calif. Red abalone shell found in association with a large number of human skeletons. This ancient cemetery was covered by a layer of cemented dune sand. Submitted by P. C. Orr.	L-290D	7050 ± 300
San Diego, Calif. Charcoal from the Texas Street site, thought to be a third interglacial alluvial fan and thought to contain evidence for early man. Submitted by G. F. Carter.	L-299D	> 35,000
Lubbock, Tex. Snail shells from the Folsom horizon. The position of the shells is slightly higher than that of the charred bones dated by Libby at 9880 ± 350 yr (*19*). This date, therefore, not only confirms the age assigned to the Folsom culture but also suggests that land snails may be a reliable radiocarbon dating material. Submitted by E. H. Sellards, Texas Memorial Museum.	L-283G	9700 ± 450

Description	Sample No.	Age (yr)
Plainview, Tex. Snail shells from the bone beds that contain the Plainview cultural materials. The accumulation of the bone bed came about from the stampede of a herd of bison, which resulted in the death or crippling of about 100 bison that were crossing Running Water Creek within the limits of the present city of Plainview. On the basis of field studies, the age of the sample had been estimated to be close to that of the Folsom culture. Submitted by E. H. Sellards.	L-303	9800 ± 500
Midland, Tex. Pond snail shells from the white sand which forms the base of the deposit. The Midland skeletal remains and artifacts were found in the gray sand that rests disconformably above the white sand. Collected by E. H. Sellards, Texas Memorial Museum, and F. Wendorf, Museum of New Mexico; submitted by E. H. Sellards.	L-304C	13,400 ± 1200
Jackson County, Ala. Charcoal from the 13-ft level in Russel Cave (*20*); estimated to be about 9000 yr old. This sample represents the oldest C^{14}-dated material directly associated with human remains in the eastern United States. Submitted by C. F. Miller, Smithsonian Institution.	L-344	7950 ± 200
New York, N.Y. Timber from remains of a ship found in a New York subway excavation. Thought to be Adrien Block's ship, the *Tiger*, which burned in New York (New Amsterdam) harbor in 1613. When found, the ship timbers were covered with layers of sand and silt totaling 11 ft in thickness. The shoreline of Manhattan Island in 1625 was at Dey and Greenwich Sts., where the timbers were unearthed. Submitted by W. M. Williamson, Marine Museum of New York City.	L-262	420 ± 80
Chiapas, Mexico. Charcoal associated with pre-Classic ceramics. The site had been estimated to be between 1600 and 2100 yr old on the basis of historical research. Submitted by T. S. Ferguson, New World Archeological Foundation, Oakland, Calif.	L-286A	1550 ± 100
Chiapas, Mexico. Charcoal from a depth of 2 m in mound A near the town of Santa Rosa. Submitted by T. S. Ferguson.	L-357	2170 ± 80
Paracas, Peru. Cotton cloth, Paracas Necropolis period; mummy 49, part of the same undyed cotton fabric dated by Libby, by the black carbon method (sample C-271), as 2257 ± 200 yr (*19*). The present result, although it is in good agreement, supports the general belief that the C-271 mean was too large. Cloth of identical type from Paracas Necropolis period, mummy 114, sample L-115, was also dated by both the black carbon and CO_2 methods as 1700 ± 200 and 1750 ± 90. These four tests suggest that, within the group burial of more than 400 Necropolis mummies, there are measurable age differences. Corroboration calls for further study of existing collections and field work concentrated on cultural horizons antedating this time bracket, and within it. Submitted by Junius Bird, American Museum of Natural History.	L-311	2050 ± 100
Viru Valley, Peru. Samples from burials at site V-162 (Huaca de la Cruz), late Mochica phase. A sample from a burial at the same site and from the same phase was dated by the University of Chicago (C-619) at 1833 ± 119 yr (*20*). The ages reported here agree better with archeological evidence for the north coast of Peru, according to W. D. Strong, Columbia University, who submitted the samples.		
Burial 3, textile fabrics, No. 500.	L-335A	1300 ± 80
Burial 10, basketry, No. 559.	L-335B	1300 ± 80
Nazca, Peru. Second series of ages relating to materials collected by the Columbia University Ica-Nazca expedition, 1952–53 (*21*). The first series was included in a previously published Lamont date list (*3*). The two series are generally remarkably consistent with each other and with the stratigraphic and stylistic evidence available for the south coast of Peru. Submitted by W. D. Strong.		
Site N-4 (Cahuachi): burial 32, human hair, No. 352. Huaca del Loro phase, Fusional epoch.	L-335F	1200 ± 90
Site N-4 (Cahuachi): burial 4, textile fragments, No. 225. Late Nazca phase, Florescent epoch. (Nazca B).	L-335E	1430 ± 90
Site N-4 (Cahuachi): burial 39, human hair and textile fragments, No. 356. Middle Nazca phase, Florescent epoch. (Nazca A).	L-335G	1620 ± 100
Site I-27 (Ocucaje II): burial 3, reeds strung with cord, No. 414. Late Paracas phase, Formative epoch.	L-335C	1840 ± 100
Site I-27 (Ocucaje II): burial 4, human hair and scalp, No. 415. Late Paracas phase, Formative epoch.	L-335D	1940 ± 100
Catamarca Province, Argentina. Charcoal from dwelling place at Site No. 10, Hualfin Valley, near the juncture of the Rio Guiyischi (Huiliche). The sample was associated with pottery types "Ciénaga polychrome" and "Huiliche monochrome" of the Barreales culture. Collected by Rex Gonzalez, Universidad Nacional de La Ciudad La Plata. Submitted by Junius Bird.	L-307	1130 ± 90
Tarascon, France. Charcoal from a depth of 10 to 20 cm in the late Magdalenian horizon of the Grotte de la Vache. Estimated age, 10,000 to 12,000 yr. Collected by R. Robert, Tarascon (Ariége), France, and H. Gross, Bamberg, Germany, and submitted by H. L. Movius, Jr., Peabody Museum, Harvard University.	L-336C	11,650 ± 200
Chambéry, France. Lignite from the Voglans-Sonnaz locality. The horizon from which the sample was taken is believed to be of third interglacial (Riss-Würm) age. A sample from the nearby Lake Bourget locality was dated by the Chicago laboratory as > 21,000 years (sample C-588) (*19*). Collected by L. Moret, University of Grenoble, France, and submitted by H. L. Movius, Jr.	L-336A	> 39,000
La Colombière, France. This is a large rock shelter, near Poncin (Ain). The sample consisted of ashy material	L-177	14,150 ± 450

Description	Sample No.	Age (yr)
from a hearth in a Gravettian (or Upper Perigordian) occupation layer resting immediately upon and interdigitated with the last depositional stages of the 20- to 23-m terrace of the Ain River. It has been thought that this site should be quite a bit older than the Lascaux site dated by Libby (*19*) at 15,500 ± 900 yr. A sample from this same hearth, measured at the U.S. Geological Survey C^{14} laboratory (sample W-150) (*4*) gave an age of 11,650 ± 600 yr. Collected and submitted by H. L. Movius, Jr.		
Tarragona, Spain. Sample of ashes from a prehistoric level under the city of Tarragona. Submitted by W. L. Bryant Foundation, Springfield, Vt.	L-280	2050 ± 130
Angelsta, Sweden. Tree rings (No. 101 to 150, counting from the center) from a Neolithic fir tree found at a depth of 3.5 m in Rya Moor. This sample has been circulated as a radiocarbon standard. A similar sample was dated by the Stockholm Radioactive Dating Laboratory as 2470 ± 65 yr old (St-156) (*22*). Submitted by G. Ostlund, Stockholm, Sweden.	L-296	2600 ± 80
Shanidar Cave, Kurdistan, Iraq. Samples from layer C, the second oldest of four cultural layers ranging from modern back to Mousterian of the middle Paleolithic period (*23*). Duplicates of these samples were run by the U.S. Geological Survey laboratory (*4*), ages of 29,500 ± 1500 (W-178) and > 34,000 yr (W-180) being obtained. The agreement is satisfactory. Collected by R. Solecki, Smithsonian Institution, and submitted by W. D. Strong.		
Impure charcoal from the upper part of layer C, the Baradost culture (related to the Aurignacian in Western Europe). Field catalog No. 338, square S3W1, 10.0 ft below the datum plane.	L-335H	26,500 ± 1500
Charcoal from 2 ft above the base of layer C. Field catalog No. 401, square S2W4, 15.0 ft below the datum plane.	L-335I	32,300 ± 3000
Dothan, Jordan. Charcoal from cooking areas and what appears to be burned roof beams from the Biblical site of Dothan, located 60 mi. north of Jerusalem. The age assigned from pottery remains and other archeological data is 900 to 800 B.C. Submitted by J. P. Free, Wheaton College.	L-365	2760 ± 80
Mount Carmel Range, Israel. Charcoal from the Upper Levalloiso-Mousterian level of the Mugharet-el-Kebara, a site located south of Haifa. This level is correlated with level B at the nearby Mugharet-et-Tabum, where several Neanderthal burials were discovered. The age calculated is 33,000 yr, but because of the small size of the sample, the error slightly overlaps the sensitivity limit, and hence a minimum age is quoted. Collected by M. Stekeles, Hebrew University, Jerusalem, and submitted by H. L. Movius, Jr.	L-336D	> 30,000
Bortal Fakher, Tunisia. Charcoal from a lower Capsian archeological site in southern Tunisia. Compared with the age of 7300 yr obtained on an Upper Capsian sample (L-240B) (*3*) from Khanquet-el-Mouhaad, the age on sample No. 1 appears to be too young. Remeasurement of this sample gave the same age. A second sample from the same locality gave a slightly greater but still somewhat younger age than expected. Collected by E. G. Gobert, Tunis, Tunisia. Submitted by H. L. Movius, Jr.		
Sample No. 1.	L-240A	6900 ± 150
Sample No. 2.	L-366I	7700 ± 200

Table 3. Radiocarbon dates on samples of ocean sediment.

Description	Sample No.	Age (yr)
Core A179-15. Taken at 3110-m depth at lat. 24°48′N, long. 75°55′W off Eleuthera Island, Bahamas, from a steep slope. The core consists mainly of calcilutite with a layer of calcareous silt near the base of the section. A description of the lithology and the climatic implications of the core has been published (*5*). Collected by M. Ewing.		
Depth 0 to 1 cm.	L-332A	1000 ± 230
Depth 0 to 3 cm (from trigger weight core).	L-332B	1300 ± 225
Depth 49 to 50.5 cm.	L-332C	4530 ± 300
Depth 129 to 132 cm.	L-332D	15,900 ± 600
Core V3-126. Taken at a depth of 3485 m in the Gulf of Mexico at lat. 23°45′N, long. 92°28′W. The sample taken at 23- to 27-cm depth was taken close to the end of the period of increase in surface water temperature. The details of the lithology and the significance of the age measurement are given by Ewing, Ericson, and Heezen (*24*). Collected by M. Ewing.	L-332O	7900 ± 450
Core V3-127. Samples from a core taken in the Gulf of Mexico on a topographic high in the Sigsbee Deep at lat. 23°38′N, long. 92°40′W, water depth 3540 m. A complete description of this core and the significance of these measurements is given by Ewing, Ericson, and Heezen (*24*). Bulk carbonate material was run in each case. Collected by M. Ewing; submitted by D. B. Ericson, Lamont Geological Observatory.		
Depth 35 to 45 cm.	L-343C	12,870 ± 400
Depth 68 to 95 cm.	L-343D	19,650 ± 1200
Depth 134 to 144 cm.	L-343E	23,830 ± 1500
Depth 185 to 192 cm.	L-343A	25,850 ± 2000
Core A185-35. Samples from a core taken in the Gulf of Mexico at a depth of 3630 m, lat. 24°34′N, long. 92°37′W. The measurements were on bulk core		

Description	Sample No.	Age (yr)
material in each case. A complete description of the core and the significance of these measurements has been published (*24*). Collected by M. Ewing; submitted by D. B. Ericson.		
Depth 103 to 109 cm.	L-343B	10,900 ± 1000
Depth 650 to 670 cm.	L-343F	20,000 ± 2000
Core A172-2. Taken at 3070-m depth in the Caribbean Sea at lat. 16°12′N, long. 72°19′W. The comparison between the coarse and the fine fractions substantiates Suess' data indicating that the fine fraction from cores taken in regions of rather steep topography may contain reworked carbonate. C^{14} measurements on such material would give maximum ages. Collected by M. Ewing.		
Depth 14 to 29 cm; > 74 μ fraction.	L-332P	11,050 ± 200
Depth 14 to 29 cm; < 74 μ fraction.	L-332R	13,500 ± 400
Core A179-8. Taken at 4060-m depth at lat. 20°28′N, long. 72°49′W, northwest of the island of Hispaniola on the Caicos-Hispaniola abyssal plain. The core contains numerous layers of calcareous sand, probably because of slumping or turbidity currents. The normal sediment from which the samples were taken consists of lutite. The details of the lithology and the climatic implications of the core have been published (*5*). Collected by M. Ewing.		
Depth 0 to 2 cm.	L-332G	9900 ± 700
Depth 268 to 275 cm.	L-332H	13,750 ± 300
Core A180-74. Samples of bulk carbonate from a core taken from a depth of 3320 m at lat. 00°03′S, long. 24°10′W in the Atlantic Ocean. The core consists of uniform foraminiferal lutite with no obvious evidence of turbidity currents, erosion, slumping, or reworked sediments. The excellent agreement in lithology between this core and three others taken on a 400-km traverse across the mid-Atlantic ridge in the equatorial region indicates that this core represents an undisturbed record of sedimentation. The details of the lithology and climatic implications of this core have been published (*5*, *25*). Collected by B. C. Heezen.		
Depth 9 to 12 cm.	L-332K	8000 ± 500
Depth 26 to 33 cm.	L-332J	13,250 ± 600
Depth 175 to 186 cm.	L-332I	> 40,000
Core A180-76. Taken at 3510-m depth at lat. 00°46′S, long. 26°02′W. This core is similar in almost every respect to core A180-74. The purpose of the two measurements was to determine whether the coarse and fine fractions of the carbonate material would give the same age. Measurements by Suess (*4*) in other areas suggest that the fine material contains reworked carbonate and hence gives an anomalously old age. This does not seem to be the case in these cores. Collected by B. C. Heezen.		
Depth 10 to 22 cm; < 74 μ fraction.	L-332E	9500 ± 180
Depth 10 to 22 cm; > 74 μ fraction.	L-332F	10,500 ± 250
Core A180-93. Taken at a depth of 4114 m at lat. 13°04′S, long. 36°26′W. The sample consisted of bulk carbonate material taken at the mid-point of the temperature change (20- to 30-cm depth). The same comments as those made for core A180-100 apply to this one. Collected by B. C. Heezen.	L-332N	15,000 ± 550
Core A180-100. Taken at a depth of 4260 m at lat. 17°28′S, long. 34°58′W. This core was chosen in order to determine whether the temperature change in the surface waters of the South Atlantic Ocean correlated in age with that in the north Atlantic (*5*). Although this core is the best available, it is from an area where slumping may have brought in reworked material. Since the amount of coarse fraction was exceedingly small, the bulk material was measured. The ages quoted are maximum owing to the possibility of the presence of reworked carbonates. The mid-point of the temperature change falls at 30 cm, indicating that the change occurred less than 20,000 yr ago. Collected by B. C. Heezen.		
Depth 0 to 8 cm.	L-310A	5000 ± 250
Depth 25 to 35 cm.	L-310B	20,000 ± 900
Depth 60 to 80 cm.	L-310C	35,000 ± 4000

Table 4. Radiocarbon dates on Pluvial Lake samples.

Description	Sample No.	Age (yr)
Lake Lahontan area, Nev. The following measurements were made as part of a program designed to reconstruct the pattern of the climatic variations in the western part of the Great Basin (*26*). Since a large majority of the measurements were made on carbonate materials, a study has been made of the validity of such materials as indicators of radiocarbon age (*10*). The samples were collected as part of a joint project by P. C. Orr and W. S. Broecker.		
Large oolites from a beach about 60 ft above the present lake level in the Pinnacles area at the north end of Pyramid Lake. Elevation is about 3870 ft.	L-288F	1100 ± 200
Shells from an extensive shell beach on Anaho Island about 50 ft above the present level of Pyramid Lake. Elevation about 3860 ft.	L-288H	2100 ± 200
Basketry from the upper portion of the deposits in Crypt Cave. This wave-cut cave is located on the east side of dry Lake Winnemucca at an elevation of about 370 ft above the present level of Pyramid Lake. Elevation about 4170 ft.	L-289II	2400 ± 200
Wood fragments from a habitation level 32 in. below the surface of the deposits in Hidden Cave, a wave-cut	L-289BB	3050 ± 200

Description	Sample No.	Age (yr)
cave in the Fallon area. Elevation 4104 ft.		
Twigs from a habitation level composed mainly of guano and dust 22 to 28 in. below the surface of the deposits in Guano Cave, which is located about 270 ft above the present level of Pyramid Lake on the east side of dry Lake Winnemucca. These deposits are covered by a 6-in. layer of silt which was probably washed in from another part of the cave. Elevation about 4050 ft.	L-356B	3200 ± 130
Shell from a remnant of lake sediments in the floor of wave-cut Diaphragm Cave, which is located at the water level on the east side of Pyramid Lake just north of the Pyramid. Elevation 3820 ft.	L-289R	3200 ± 250
Black pitchlike material found on the ceilings and walls of most of the caves in the area. P. C. Orr, who has studied these deposits, is convinced that they are not from smoke. One theory is that they consist of organic material leached from the tufa which covers the inside of all the caves. The young age seems to rule out this possibility.	L-364BI	4150 ± 150
Matting associated with a human burial in Cow Bone Cave, which is located on the east side of dry Lake Winnemucca. Elevation 4020 ft.	L-289FF	5970 ± 150
Fragments of netting from the topmost portion of the lowest habitation level in Fishbone Cave, which is located on the east side of dry Lake Winnemucca at an elevation of about 250 ft above the present level of Pyramid Lake. Elevation about 4050 ft.	L-289KK	7830 ± 350
Tufa from a large mushroom-shaped carbonate mound located about 100 ft above the present lake level in the Pinnacles area at the north end of Pyramid Lake. The sample was the outermost of a series of concentric layers of various varieties of tufa. Elevation about 3900 ft.	L-364CE	8500 ± 200
Lithoid tufa from about 165 ft above Crypt Cave. This sample is from about 100 ft below the highest known level of the lake. Elevation about 4330 ft.	L-289G	9700 ± 200
Duplicate of sample L-289G, collected 9 mo later. Elevation about 4300 ft.	L-356G	10,000 ± 220
Lithoid tufa from about 110 ft above Crypt Cave. Elevation 4280 ft.	L-356H	9700 ± 200
A second sample taken from the same place as L-356H. Elevation 4280 ft.	L-364DA	10,700 ± 240
Lithoid tufa from the Lahontan beach level in the Winnemucca Cave area. This sample was the highest tufa observed in the area and came from within 50 ft of the maximum recognized Lahontan level. Elevation about 4380 ft.	L-364AA	9500 ± 200
Lithoid tufa from crevices in the rocks at the top of Anaho Island, which nearly coincides with the maximum lake level. Elevation about 4380 ft.	L-289N	11,800 ± 200
Lithoid tufa from the Mullen Pass area on the west side of Pyramid Lake. The elevation of the sample was nearly the same as that of L-289N. Elevation about 4360 ft.	L-289I	11,250 ± 350
Tufa from the lithoid terrace located 50 ft below the maximum level attained by Lake Lahontan. The sample was collected on Anaho Island. Elevation about 4330 ft.	L-289M	11,700 ± 200
Lithoid tufa from an elevation of about 400 ft above the present level of Pyramid Lake, on Anaho Island. Elevation about 4200 ft.	L-289L	11,570 ± 250
Lithoid tufa from the entrance of Fishbone Cave. Elevation about 4050 ft.	L-289C	11,700 ± 500
Tufa from a thick multilayer plate which divides Diaphragm Cave into an upper and a lower room. The sample itself was layered. Individual measurements on the upper and lower portions showed no significant difference in age. Elevation 3820 ft.	L-289H	12,700 ± 300
Radiating mushroom-shaped tufa masses forming a pavement within the upper clay members of the sediments exposed in the canyon of the Truckee River just south of the Agency Bridge in Nixon. The sample elevation is about 200 ft above the level of Pyramid Lake. Elevation 4002 ft.	L-289S	12,900 ± 350
Sample from radiating tufa from the same pavement as sample L-289S but 1 mi further south along the river. Elevation about 4020 ft.	L-364AM	12,700 ± 300
Mammillary material forming the base of sample L-364AM. Elevation about 4010 ft.	L-364AN	13,700 ± 300
Dendritic tufa forming one of the concentric layers in the mushroom described for sample L-364CE. The sample comes from a distance of 1.5 ft from the surface of the 16-ft diameter mushroom. Elevation about 3900 ft.	L-364CI	14,500 ± 400
Shell from sand found immediately below the terrestrial or habitation deposits in Fishbone Cave. Elevation about 4050 ft.	L-289P	15,130 ± 550
Tufa from a broken piece of a diaphragm which once divided Fishbone Cave. The piece was found resting on the mud-cracked surface of the lake sediments that fill the bottom of the cave. Elevation about 4050 ft.	L-289D	14,800 ± 500
Piece of a tufa diaphragm found in place buried in the sediments at a depth of 72 in. in Hidden Cave. Elevation about 4100 ft.	L-289AA	15,130 ± 400
Shells from near the top of a sequence of lake sediments found under the habitation layers in Fishbone Cave. Elevation about 4050 ft.	L-289O	15,670 ± 700
Dendritic tufa from the base of the large deposits associated with the Dendritic terrace on Anaho Island. The sample elevation is about 300 ft above the present level of Pyramid Lake. Elevation about 4100 ft.	L-289K	16,130 ± 750
Shell from near the top of the sequence of lake deposits in Crypt Cave. Elevation about 4170 ft.	L-364BR	18,700 ± 700
Marl from near the base of the lake sediments deposited in Crypt Cave. Elevation about 4170 ft.	L-364BS	19,750 ± 650
Impure marl from a thin layer located 4 ft below the tufa pavement in the sediment sequence cut by the Truckee River. Elevation about 4005 ft.	L-364AL	17,600 ± 650

Description	Sample No.	Age (yr)
Marl deposited at the Dendritic terrace level at the heads of valleys in the Astor Pass region north of Pyramid Lake. Elevation about 4150 ft.	L-364CR	16,800 ± 600
Shell taken from sample L-364 CR.	L-364CS	17,500 ± 600
Thinolite tufa associated with the Thinolite terrace on Anaho Island. The sample elevation is about 180 ft above the present level of Pyramid Lake. Elevation about 3980 ft.	L-289J	28,900 ± 1400
Shell taken from the base sandy member of the sediments exposed in the canyon of the Truckee River. This sandy layer lies immediately below the clay member from which samples L-364AM, L-364AL, and L-289S were taken. Elevation about 3990 ft.	L-364AK	> 34,000
Salt Lake City, Utah. Tufa from the three major Lake Bonneville terraces taken in a vertical sequence at the southern tip of the Oquirrh Mountains just west of Salt Lake City. Collected by R. Davis and O. A. Schaeffer, Brookhaven National Laboratory; A. J. Eardley, University of Utah; P. C. Orr and W. S. Broecker.		
Massive tufa from a gravel bed at the Stansbury level.	L-363B	13,200 ± 300
Tufa forming a 4-in. thick coating on the surface of a wave-cut Paleozoic limestone outcrop on the Stansbury terrace.	L-363C	12,900 ± 180
Tufa forming a 4-in. thick coating on a horizontal surface of a Paleozoic limestone outcrop exposed on the Provo terrace.	L-363D	10,900 ± 400
Tufa forming a coating on a vertical face of limestone just below the Provo terrace. Although this sample was taken within 500 ft. of sample L-363D, it was a completely different structure.	L-363E	15,530 ± 280
Fine grain massive white tufa deposited as a cement between stream cobbles located close to the Bonneville level. The sample consisted of several plates of tufa about 1 in. thick and quite free of any inclusions of detrital material.	L-363G	16,100 ± 350
Tufa forming a thin coating on a large boulder located near the level of the Bonneville terrace.	L-363H	23,150 ± 1000
Dugway Proving Ground, Utah. Samples from the white marl layer exposed in the "Old River" bed just south of the limits of Dugway Proving Ground limits. According to Gilbert (27), who described this sedimentary sequence, the deposition of the marl occurred while the lake stood at the Bonneville level. Collected by R. Davis, O. A. Schaeffer, and P. C. Orr.		
Poorly laminated marl from approximately the middle of the bed.	L-363I	23,300 ± 800
Finely laminated marl from somewhat above L-363I.	L-363J	21,200 ± 450
Great Salt Lake, Utah. Samples from a core taken near the southern end of the lake west of Salt Lake City at a water depth of about 28 ft. The samples are from immediately above and below a layer rich in organic material and H_2S. This layer was presumably deposited during a major continuous high-water stage of the lake. Submitted by A. J. Eardley, University of Utah, and J. F. Schreiber.		
Limey silt and clay from a depth of 14 to 16 ft in the core.	L-376C	12,500 ± 250
Organic fraction. Limey silty clay from a depth of 30 to 32 ft in the core.	L-376D	26,300 ± 1100
Inorganic or carbonate fraction from the same sample.	L-376D	25,300 ± 1000
Provo, Utah. Samples of tufa collected from the shorelines of pluvial Lake Bonneville in the West Mountain region. The dates on these samples should indicate times at which the water level of the lake was at or possibly above the height of the tufa deposit. Collected by H. J. Bissell, Brigham Young University, upon the request of B. C. Heezen and W. S. Broecker.		
Tufa from the Stansbury level (about 330 ft above the present level of Great Salt Lake) at Lincoln on the north end of West Mountain. Elevation is 4520 ft.	L-333A	25,500 ± 1300
Tufa from the Provo level (about 580 ft above the present level of Great Salt Lake) on the north end of West Mountain. Elevation 4780 ft. Since this sample consisted of a limestone conglomerate cemented with tufa, even careful separation does not assure freedom from contamination with Paleozoic limestone. The age calculated is hence a maximum.	L-333B	33,200 ± 4000
Tufa from a level intermediate between the Provo and Stansbury levels from the west side of West Mountain. Elevation 4690 ft.	L-333C	15,200 ± 400

References and Notes

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7. The credit for the collection of and for the micropaleontologic work on the core samples for which ages were given in a previous date list (3) was omitted by mistake during the final revision of the paper. M. Ewing and B. C. Heezen were responsible for the collection of the samples, and D. B. Ericson was responsible for the micropaleontologic work.
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News of Science

Soviet Satellite Carrier Rocket

On 8 December 1957 the president and the chief scientific secretary of the U.S.S.R. Academy of Sciences addressed a cable to the president of the U.S. National Academy of Sciences regarding the rocket carrier body of the first artificial earth satellite, which was launched on 4 October 1957. A similar cable was addressed on 9 December to Joseph Kaplan, chairman of the U.S. National Committee for the International Geophysical Year, by Academician I. P. Bardin, president of the Soviet IGY Committee. Because the substance of these two cables is identical, only the first is quoted:

DETLEV BRONK, *President*
National Academy of Sciences

According to available data some not entirely burnt remnants of the first earth satellite rocket have been scattered along a line including Alaska and the west coast of North America. A thorough investigation of the not entirely burnt rocket remnants and the knowledge of the exact places of their fall are of great scientific significance as they provide valuable data concerning phenomena occurring when satellites enter the denser atmospheric layers. The USSR Academy of Sciences asks all the USA scientists to communicate the data concerning the fall of the rocket remnants and to send the remnants which were found to the Academy of Sciences Moscow USSR.

President of USSR Academy of Sciences
ACADEMICIAN A. N. NESMEYANOV
Chief Scientific Secretary of USSR Academy of Sciences
ACADEMICIAN TOPCHIEV

Although no evidence had come to light indicating that the rocket body of the first satellite had fallen in North America, a review of all available data and reports was initiated on 6 December when press dispatches from Moscow indicated that the U.S.S.R. believed the carrier body may have fallen on this continent. The results of this review, as of 11 December, were negative, and, on the same day, the president of the National Academy of Sciences accordingly addressed the following reply to the U.S.S.R. Academy:

PRESIDENT A. N. NESMEYANOV
Academy of Sciences of U.S.S.R.
Moscow

Reference your message and message Bardin to Kaplan our review thus far of sightings and trackings of satellite and investigation of reports of objects sighted do not indicate rocket or remnants fell in United States or its territories. We have no reports of finding of any such bodies. Your request being transmitted to trackers and others. It will be helpful if you can provide data you mention as available to guide our further search.

DETLEV W. BRONK, *President*
National Academy of Sciences
U.S.A.

Several observation programs are under way in the United States as part of the IGY effort in the tracking of all satellites. Photographic and visual tracking responsibilities have been assigned to the Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass. Radio tracking responsibilities have been assigned to the Naval Research Laboratory, Washington 25, D.C. Reliable information on satellite sightings would be welcome. Photographic and visual data should be addressed to the Smithsonian Astrophysical Observatory and, similarly, radio data to the Naval Research Laboratory.

HUGH ODISHAW
U.S. National Committee for the International Geophysical Year, National Academy of Sciences, Washington, D.C.

AAAS Theobald Smith Award

Paul Talalay, associate professor, Ben May Laboratory for Cancer Research, University of Chicago, is the winner of the 1957 AAAS Theobald Smith award in the medical sciences. This annual award, which was established by Ely Lilly and Company in 1936, consists of $1000, a bronze medal, travel expenses to the annual AAAS meeting, and expenses at the meeting. This year's award will be made on 29 December during the Association's annual meeting in Indianapolis by William B. Bean, vice president and chairman of the AAAS section on medical sciences.

The award is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." The recipient must be a U.S. citizen less than 35 years old on 1 January of the year in which the award is made.

Talalay's main interest has been in the enzymatic mechanisms controlling steroid metabolism. Realizing the advantages that bacteria would have for such studies, he isolated soil bacteria that could satisfy their organic nutritional requirements from a single steroid such as testosterone or progesterone. Talalay was the first to isolate and purify the water-soluble enzymes responsible for the interconversions of hydroxy- and ketosteroids. He also demonstrated that these enzymes, which he named hydroxysteroid dehydrogenases, functioned in association with the coenzyme, diphosphopyridine nucleotide.

Talalay concentrated especially upon study of the kinetics of the reactions of the hydroxysteroid dehydrogenases with a variety of steroids. He was able to demonstrate the high affinity between the enzymes and certain steroid molecules and to elucidate the molecular features of the steroid molecules that are essential for binding the steroid enzyme complex together.

Recently, Talalay has studied the mechanism of double bond introduction into steroids. These reactions are of interest in connection with the aromatization involved in the biosynthesis of phenolic estrogens, and in the formation of the highly physiologically active *l*-dehydrosteroids. He has succeeded in obtaining soluble enzyme preparations which introduce double bonds into positions 1 and 4 of ring A of steroids and convert 19-nor-testosterone to estrone and estradiol. He has demonstrated that these reactions require certain oxidation-reduction dyes and has obtained insight into the enzymatic mechanisms by which these reactions are carried out.

AAAS Election Results

The AAAS Council by mail vote has elected Paul E. Klopsteg, associate director of the National Science Foundation, as president-elect of the American Association for the Advancement of Science. Dr. Klopsteg has been a member of the AAAS Board of Directors since 1949.

William W. Rubey, research geologist with the U.S. Geological Survey, and Thomas Park, professor of zoology at the University of Chicago, were re-elected to the Board of Directors. Both terms are for four years.

Formal announcement of the election was made today at the AAAS Council meeting in Indianapolis.

British Pamphlet on Hydrogen Bomb

The British Government has issued a handbook on what to do if hydrogen bombs fall. The pamphlet, entitled *The Hydrogen Bomb,* says:

"Not only would death and destruction be on a greater scale than ever before but also there would be no easy return to normal life for the survivors. It would mean a long struggle to keep life going, and the bulk of the country's resources would be concentrated on relief and rescue in the worst stricken areas."

The pamphlet reports further that the ground burst might dig a crater about a mile across and as deep as 200 feet. "It must be recognized that within three or four miles of the hydrogen bomb all buildings would be completely, or almost completely, destroyed."

Readers are advised that woolen clothes would be less likely to catch fire than others, that windows should be whitewashed, that flammable objects should be kept away from windows and doorways, and that heating plants should be turned off. Much of the advice given is almost identical with that provided by the British Government in the autumn of 1940 when the first German bombs—the biggest then were about 550 pounds—began to fall on London.

AEC Finances

The financial report of the Atomic Energy Commission for fiscal year 1957 (year ending 30 June 1957) shows that the total investment in plant and equipment increased from $6.6 to $6.9 billion during the year. Plant retirements because of obsolescence amounted to $83 million. Other comparative expenditures and assets were as follows (figures for 1956 in parentheses): inventories of nuclear materials, $1.7 billion ($1.6 billion); cost of operations, $1.97 billion ($1.61 billion). The costs of operation included the following: procurement and production of materials, $1.2 billion ($1 billion); weapons development and fabrication, $337 million ($281 million); development of nuclear reactors, $276 million ($170 million); research in chemistry, metallurgy, and physics, $59 million ($52 million); research in cancer, medicine, and biology, $33 million ($30 million); administrative expenses, $38.5 million ($38.2 million).

During the year the AEC purchased 32.4 million pounds of uranium concentrates at a cost of $355.8 million as compared with 20.1 million pounds at $238 million in 1956. The purchase of additional source materials brought the totals up to $402 million and $281 million, respectively. Slightly more than half (53 percent) of the uranium concentrates were procured from other countries.

Research and development costs for power reactors rose from $45.8 million in 1956 to $56.7 million in 1957, and reactor construction costs rose from $9.4 to $33.3 million.

Operating costs of the AEC research laboratories increased from $233.1 to $289.3 million. Some of the allocations for research in special fields were as follows (in millions): chemistry, $19.4; metallurgy, $6.1; physics, $28.7; cancer, $3.4; medicine, $9.2; biology, $11.6; biophysics, $4.4; dosimetry and instrumentation, $1.9.

Visiting Professors in Astronomy

The American Astronomical Society has announced the inauguration of a program of Visiting Professors in Astronomy for the first half of 1958. The program, made possible by a grant from the National Science Foundation, aims to strengthen and stimulate college programs in astronomy and in the other physical sciences; to give astronomers and other scientists opportunity for contact with creative astronomers from other universities and observatories; and to motivate good college students to consider careers in astronomy or one of the other physical sciences.

The visiting professors are ready to give general college addresses or lectures to astronomy classes, or to participate in seminars. They will be glad to advise students on opportunities for advanced study and employment in astronomy, and to discuss teaching problems and curriculum with members of the faculty. In short, the lecturers will cooperate with the colleges in all ways they can to further the aims of the program. A normal visit by a professor will last for two or three days.

There will be three professors in the spring of 1958: Paul W. Merrill, Seth B. Nicholson, and Harlow Shapley. Merrill will be available from February through May in the Far West. Nicholson will tour the Midwest from February through May. Shapley will lecture in the East during February and March. For further information, communicate with Dr. William Liller, the Observatory, University of Michigan, Ann Arbor, Mich.

Radiation Level Lowered

On 10 December the Atomic Energy Commission reduced by two-thirds the level of radiation exposure permitted for workers in the atomic facilities of the commission, the people living near those facilities, and workers in the atomic facilities of the commission's contractors. The new standards do not affect the operations of private companies licensed to use radioactive materials, but the commission said that it will amend the regulations governing private companies so that they will conform to the new standards.

The new levels follow the recommendations made in January 1957 by the National Committee on Radiation Protection and Measurement, an intergovernment committee that has been advising on radiation exposure for more than twenty years. The national committee stated that "changes in the accumulated maximum permissible dose are not the result of evidence of damage due to the use of earlier permissible dose levels, but rather are based on the desire to bring the maximum permissible dose into accord with the trends of scientific opinion."

For the first time atomic workers are placed on a schedule that limits the accumulated radiation exposure over the years. A worker may receive an average exposure of 5 rem per year and not more than 15 rem in any one year. (The term *rem,* which stands for roentgen equivalent man, is used for a radiation dose of any ionizing radiation which is estimated to produce a biological effect equivalent to that produced by one roentgen of x-rays.) In the past, workers could receive up to 15 rem every year; there was no provision to control the accumulated exposure over the years. The commission said that, in practice, the radiation exposure of nearly all the workers in commission facilities has been below the new standards. People living near atomic facilities may receive one-tenth of the exposure permitted atomic workers, which is the same ratio employed in the earlier regulations.

In line with another recommendation by the national committee, the commis-

sion established, also for the first time, regulations designed to limit the radiation exposure received from atomic operations by the population as a whole. The commission said that its industrial operations must not release any radiation that might be expected to expose members of the populace to an average whole body dosage exceeding 0.5 rem per year.

News Briefs

The Institute of Mathematical Sciences at New York University offers temporary memberships to mathematicians and other scientists holding the Ph.D. degree who intend to study and do research in the fields of mathematical physics, applied mathematics, and related fields of mathematical analysis. The program is being supported by the National Science Foundation and also by funds contributed by industrial firms.

Requests for information and for application blanks should be addressed to the Membership Committee, Institute of Mathematical Sciences, 25 Waverly Place, New York 3, N.Y.

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The name of the Bioacoustics Laboratory of the University of Illinois has been changed to the Biophysical Research Laboratory of the College of Engineering.

* * *

The United States, Great Britain, and the Soviet Union have set off more than twice as many atomic explosions this year as in any other year since the start of the nuclear age. So far there have been 42 announced atomic explosions—24 by the United States, 12 by the Soviet Union, and 6 by Great Britain.

* * *

The filming of the first complete course in high school chemistry will be carried out at the University of Florida. The film will be produced by the Encyclopaedia Britannica Films in time for distribution to high schools next September. The project will be financed by the Ford Fund for the Advancement of Education.

* * *

The ninth Pacific Science Congress of the Pacific Science Association opened on 18 November 1957 in Bangkok, Thailand. Orders for the Proceedings of the Congress may be placed with the Secretary-General, Dr. Charng Ratanarat, Department of Science, Ministry of Industry, Rama VI Road, Bangkok, Thailand.

* * *

The Smithsonian Institution's new Hall of North American Eskimos and Indians was opened to the public on 9 December. The new hall completes the Smithsonian's modernization of its exhibits on native peoples of the Western Hemisphere. It portrays the traditional cultures of the Indians from the eastern woodlands to the Pacific Northwest and of the Eskimos from Alaska to Greenland.

* * *

Philco TechRep Division of Philco Corporation, Philadelphia, Pa., has announced that it is making the training facilities of the Philco Technological Center available to help meet the manpower shortage in technology. Among the technical training services available are specialized correspondence courses, technical books, and training devices.

* * *

Seven million dollars were contributed recently by the U.S. Government to the heads of the World Health Organization and the Pan American Sanitary Organization to further their work in assisting governments throughout the world to eradicate malaria, which infects 250 million persons each year.

* * *

General Dynamics Corporation has begun distribution to 3500 colleges and secondary schools of a long-playing record by Edward Teller on "The Size and Nature of the Universe" and "The Theory of Relativity." Included with the recording is a new "Map of the Heavens" prepared by the National Geographic Society, and a picture-caption booklet, "The Atomic Revolution," published by the corporation, which explains the theory and peaceful uses of nuclear fission and fusion.

* * *

Establishment of the Space Technology Laboratories as an autonomous operating division of the Ramo-Wooldridge Corporation, Los Angeles, Calif., was announced recently by Dean E. Wooldridge, president. The new division is an outgrowth and extension of the former Guided Missile Research Division.

* * *

Announcement has been made by United ElectroDynamics, Pasadena, Calif., of the opening of a new facility to be called the United Testing Laboratories. This is reported to be the first integrated electronic and mechanical testing laboratory on the West Coast capable of conducting performance tests on inertial guidance systems for missiles and aircraft as well as conducting complete test programs on explosive and fusing systems.

* * *

Next summer about 2500 high school and about 250 college teachers will take part in teacher-training programs at 108 summer institutes sponsored by the National Science Foundation at a cost of $5,340,000. The Atomic Energy Commission is jointly sponsoring 12 of the institutes, which are offering courses in radiation biology for high school teachers. The foundation grants will cover tuition costs and other fees. Most institutes will pay a weekly stipend of $75 to participants; additional allowances for travel and for dependents will be made available. The program was started with two institutes in 1953 and expanded to 96 last summer.

Scientists in the News

On 7 November, the 100th anniversary of the birth of Bernard Nocht, the Bernard Nocht Medaille of the Hamburg Institut für Schiffs- und Tropenkrankheiten was given to ERNEST C. FAUST for his contributions to tropical medicine. Faust is William Vincent professor of tropical diseases and hygiene at Tulane University, and visiting professor on the medical faculty of the University of Valle, Cali, Colombia. He is serving as field coordinator in the Tulane–Colombia program in medical education, which is sponsored by the U.S. International Cooperation Administration and the Colombian Government to improve curricula in the seven medical schools in Colombia.

On 31 December ALAN T. WATERMAN, director of the National Science Foundation, will assume the chairmanship of the Interdepartmental Committee on Scientific Research and Development. The committee has the task of coordinating the scientific activities of a number of Government agencies, including those of the Atomic Energy Commission, the Department of Defense, and the National Science Foundation.

SAMUEL L. BUKER has joined the staff of the National Institute of Mental Health. He has been assigned to duty as mental health consultant in psychology in the Kansas City regional office of the Public Health Service, which serves Iowa, Kansas, Missouri, Nebraska, and North and South Dakota. Formerly Buker was chief clinical psychologist, Montana State Hospital and Department of Mental Hygiene.

MAURICE HILLEMAN, chief of the department of respiratory diseases at the Walter Reed Army Institute of Research in Washington, D.C., has accepted an appointment as a director of the Merck Institute for Therapeutic Research, effective 1 February. He will serve also as a member of the Scientific Operating Committee of the Merck, Sharp & Dohme Research Laboratories, a division of Merck.

In his new post, Hilleman will be responsible for the company's expanding research program in virology at West Point, Pa.

The following scientific visitors to North America from Australia have been reported by the Australian Scientific Liaison Office, 1907 K St., N.W., Washington 6, D.C.

J. L. PAWSEY, assistant chief of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, expects to be in the Washington area for a few weeks beginning 1 January.

J. V. SANDERS, senior research officer, Division of Tribophysics, C.S.I.R.O., is scheduled to leave London for New York on 4 January. The main object of Sander's trip is to study the latest developments in techniques in his field of work, which is concerned with topography, structure, and properties of surfaces, particularly those used for investigations of adsorption and catalysis. He will be visiting New York; Boston, Mass.; Providence, R.I.; Washington, D.C.; Charlottesville, Va.; Chicago, Ill.; and San Francisco. He will be in Washington 17–20 January.

J. R. VICKERY, chief of the Division of Food Preservation and Transport, C.S.I.R.O., will be leaving Australia in early January for the United Kingdom and will be traveling via the United States.

F. J. KERR, senior research officer, Division of Radiophysics, C.S.I.R.O., arrived in the United States on 7 December. During his stay in this country he plans to visit the observatories at Harvard University, California Institute of Technology, and in Washington, D.C., to study the present state of hydrogen-line radio astronomy.

F. BETT, research officer, Metallurgy Division, Australian Atomic Energy Commission, arrived in New York on 2 December to visit Atomics International, Inc., a subsidiary of North American Aviation in Los Angeles, for the purpose of inspecting the sodium reactor experiment and discussing sodium technology, with particular reference to compatibility problems and hot-tapping techniques.

G. C. WADE, Tasmanian Department of Agriculture, is in the United States for 1 year as a fellow of the Commonwealth Fund of New York. At present he is a research associate at the University of California. Early in January he will start a tour of this country to visit various U.S. Department of Agriculture experiment stations. His itinerary includes San Diego, Calif.; Tucson, Ariz.; Baton Rouge and New Orleans, La.; Gainesville and Orlando, Fla.; Athens, Ga.; Raleigh, N.C.; Blacksburg, Va.; and Beltsville, Md. He will be in Washington on 12 February.

JESSE T. LITTLETON, retired vice president of research, Corning Glass Works, Corning, N.Y., will receive the 1958 Toledo Glass and Ceramic Award in Toledo, Ohio, on 20 January. The award is to be presented in conjunction with a symposium on glass melting that will take place in the Hillcrest Hotel, Toledo, with Fay V. Tooley of the University of Illinois as moderator.

ALEX J. STEIGMAN, chairman of the department of pediatrics at the University of Louisville, is spending 3 months as visiting director of professional education at the Kauikeolani Children's Hospital, Honolulu, Hawaii. IRVINE McQUARRIE is retiring as director of professional education there.

LLOYD G. MUNDIE, former head of the infrared laboratory at the University of Michigan's Engineering Research Institute, has been appointed head of the infrared department of the systems division of Bendix Aviation Corporation.

RAYMOND R. EDWARDS, chairman of the department of chemistry at the University of Arkansas, has been named director of the university's newly created Graduate Institute of Technology at Little Rock. The institute was created by the Arkansas legislature in 1957 to provide advanced training for engineering and science graduates in basic science.

LLOYD P. HUNTER, manager of the physical research department of the Research Center, International Business Machines Corporation, Poughkeepsie, N.Y., has received a 1-year leave of absence to accept an invitation to spend a year at the Philips Gloeilampenfabrieken, Natuurkundig Laboratorium, Eindhoven, Netherlands.

ALEXANDER SILVERMAN, professor emeritus of chemistry, University of Pittsburgh, and a specialist in the chemistry of glass, has been chosen to receive the 1958 Albert Victor Bleininger Award for achievement in ceramics. The award has been given each year since 1948 by the Pittsburgh section of the American Ceramic Society.

ALLEN S. DUNBAR, formerly manager of advanced technical planning for the Dalmo Victor Company, electronics firm in Belmont, Calif., has been named staff scientist in the Lockheed Missile Systems Division's antenna and propagation department, Sunnyvale, Calif.

DOUGLAS H. K. LEE, chief of the research branch, Office of Research and Engineering, Office of the Quartermaster General, Washington, D.C., is taking up the position of assistant scientific director for research, Quartermaster Research and Engineering Command, Natick, Mass.

STEPHEN E. MALAKER, general manager of the Daystrom Nuclear Division of Daystrom, Inc., West Caldwell, N.J., has been named professor of nuclear engineering at the Newark College of Engineering. While he will be a member of the college's department of physics and will teach both undergraduate and graduate courses, he will also serve as chairman of a faculty committee to develop a further program of education in nuclear science and engineering.

B. F. SKINNER, professor of psychology at Harvard University since 1948, will become the Edgar Pierce professor of psychology at Harvard on 1 January. He succeeds EDWIN G. BORING, who retired last summer.

MILTON GREENBERG, director of the Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass., has been awarded the Exceptional Civilian Service Medal by the Secretary of the Air Force for "his unusual efforts as an organizer, manager, and leader."

RICHARD G. FOLSOM, director of the University of Michigan's Engineering Research Institute, has been elected president of Rensselaer Polytechnic Institute. He will assume the new post on 1 March, succeeding LIVINGSTON M. HOUSTON, president of R.P.I. since 1943, who is retiring.

GEORGE W. PETRIE, III, has been named to the newly created post of manager of research relations at the International Business Machines Corporation Research Center, Yorktown, N.Y. He will be in charge of all I.B.M. research relations with Government agencies, universities, and scientific societies. Petrie has been serving as program manager, special defense, at I.B.M.'s Washington, D.C., office.

FREDERICK A. WOLF, of Durham, N.C., has received the Cigar Industry Annual Research Award in recognition of his contributions to the botany and pathology of the tobacco plant. The annual award is sponsored jointly by the Cigar Manufacturers Association of America and the Cigar Institute of America.

T. FINLEY BURKE, former member of the senior staff of the Ramo-Wooldridge Corporation, has joined the Rand Corporation, Santa Monica, Calif., as a member of the senior staff of the electronics department.

Erratum: In the death notice for J. C. Jensen that appeared on page 968 of the 8 November issue of *Science*, it was incorrectly reported that Dr. Jensen had taught for 42 years at the University of Nebraska. Dr. Jensen was on the faculty of Nebraska Wesleyan University.

Reports

Some Characteristics of a Continuously Propagating Cell Derived from Monkey Heart Tissue

The transformation of cells, in the course of cultivation of normal tissue, with the development of the property for unlimited growth, has long been known (*1*) and, in recent years, has been reported repeatedly. Such a continuously propagating cell line, derived from a culture of trypsinized heart tissue of an apparently normal cynomolgus monkey, has been under investigation in this laboratory, in part because of the desirability of developing an established cell line for propagation of virus for vaccines for human use (*2, 3*).

Because of the unresolved doubt concerning the possibility of inducing neoplasia by the injection of vaccines prepared from virus cultivated in continuously propagating cell lines, the use of such cells for this purpose has been avoided. Since the cell line to which reference is made here was of simian and not of human origin, it seemed that it could be tested more readily for neoplastic potential in the native animal from which it arose than could cells of human origin, and that the question could possibly be answered directly. The answer was sought in tests done in more than 200 rhesus and cynomolgus monkeys, inoculated since June 1956 with different quantities of cells administered via different routes. Thus far, there is no evidence of malignant neoplasia; however, in a number of instances, rather large (3 to 4 cm in diameter) localized tumors were induced by inocula containing from 1 million to 50 million cells injected subcutaneously. In some animals, palpably detectable growth of cells has resulted from smaller inocula. All tumors regressed completely after 2 weeks to 3 months, and none have been observed to return or to reappear in other locations. The absence of evidence of malignant effects in untreated monkeys is in contrast to the findings of Coriell and his associates (*4*) that, in weanling rats treated with x-rays and cortisone, the continuously propagating monkey heart cell line, given intraperitoneally, multiplied and caused death.

In monkeys in which tumors regressed, or in animals inoculated with sufficient quantities of whole or of lysed cells, cytotoxic antibody appeared in the serum; it was also observed that such monkeys were refractory to the formation of new tumors. These findings are not unlike those observed for a transplantable rat tumor (*5*), where cytotoxic antibody and immunity developed in rats in which tumors regressed.

It seemed important to study the relationship of this to other cells. This is being done by measurements of cytotoxic antibody by a technique that is similar in principle to a tissue-culture color-test used for measuring cytopathic effect of poliovirus (*6*). It is the usual serologic practice to test a serum for the extent to which it can be diluted before extinction of the particular property that is being measured; in this case, dilutions of serum would be tested against a constant concentration of metabolizing cells. In certain instances, the optimal concentration of cells may be difficult to select with sufficient accuracy, within a range that is sometimes critically narrow; therefore, there is some advantage to an alternative procedure in which the serum component is kept constant and the cytotoxic effect is determined upon a graded series of cell concentrations. Although the details to follow describe a procedure based on the latter scheme, the principles that apply are the same for measurements of cytotoxic activity in either dimension.

Into each of a series of 13 by 100 mm test tubes is placed 0.25 ml of the desired dilution of unheated test serum (usually 1:4). Mixture 199 is used as diluent; to it is added 3 parts per 100 of 2.8 percent $NaHCO_3$ solution, 0.02 mg of phenol red per milliliter, and antibiotics in the following concentrations: penicillin, 200 units/ml; dihydrostreptomycin, 10 μg/ml; mycostatin (Squibb), 40 units/ml; and tetracycline, 10 μg/ml. To each tube containing test serum, or control substance, is then added 0.5 ml of one of a series of different cell concentrations, prepared by suspension in mixture 199, to which has been added $NaHCO_3$, antibiotics, and 10 parts per 100 of calf serum (Seitz-filtered and heated at 56°C for ½ hour).

The cell suspension is usually prepared from 6- to 7-day cultures maintained in continuous passage in a medium consisting of mixture 199 plus $NaHCO_3$, antibiotics, and 10 percent calf serum. The growing cells are detached from the glass surface of the flask by treatment with 0.25 percent trypsin solution (Difco 1:250 Trypsin), centrifuged at 500 rev/min for 5 minutes, and resuspended for cell count and adjustment to the required cell concentration. The range of cell concentrations used in the test is from 320,000 per 0.5 ml to 625 per 0.5 ml or less; however, the majority of tests have been done by using eight twofold steps from 80,000 to 625 cells per 0.5 ml. (When trypsinized tissue is used, rather than cultured cells, concentrations are expressed as dilutions of packed cells sedimented at 500 rev/min for 5 minutes; the range of dilution has been from 1:50 to 1:52,200, depending upon the degree of activity of the particular tissue suspension.)

After the serum-cell mixture is overlayed with 0.5 ml of heavy mineral oil, it is incubated at 36.5° to 37.0°C; the *p*H of the reaction mixture at the start is about 7.6, and upon overnight incubation, or even in a few hours, in tubes containing a sufficient number of actively metabolizing cells, the *p*H will fall to 6.8 and the phenol red will turn yellow. In tubes containing smaller numbers of cells, or cells that metabolize more slowly, the color change proceeds more or less slowly, with variations from red through orange and then yellow, indicating *p*H values that can be assigned by comparison with a stable set of standards; final readings are made at 7 days, or sometimes later, depending upon the purpose of the test.

Since the cytotoxic activity of serum is relative and is established on the basis of comparison with a control serum, the indications of trends are often evident from overnight incubation. When cells fail to metabolize, the *p*H is 8 or above and is identifiable by comparison with the color of medium without added cells. The *p*H's of individual tubes are recorded, and the numerical value for the highest number of cells, in the twofold cell-dilution series, that induces sufficient metabolic activity to result in *p*H of 7.4 is used for expressing quantitatively the degree of cytotoxic activity; the higher numbers reflect the greater degree of cytotoxicity.

Antisera from monkeys inoculated with the continuously propagating heart

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All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details, see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

cell exhibit cytotoxicity for this cell but exhibit little or no cytotoxicity for cells from primary cultures of monkey kidney or heart tissue. On the other hand, antisera from inoculated chicks are cytotoxic both for the continuously propagating cell line and for cultured cells from tissues of these organs. Thus, the common antigen or antigens between the continuously propagating cell line and the cells derived from freshly extirpated organs of the monkey is revealed by the chick; the monkey, however, reveals the existence of another antigen in the continuously propagating heart cell that is not present in cells from freshly removed organs of the monkey.

The antiserum for the continuous monkey heart cell line is also highly cytotoxic for the following continuously propagating human cell lines derived from both normal and neoplastic sources: human carcinoma (HeLa, HEP-2, KB); human embryo [intestine (Henle)]; human marrow (Detroit 6); human conjunctiva and liver (Chang); human heart (Girardi).

The cytotoxic effect of both monkey and chick antisera has also been demonstrated for trypsinized suspensions of cells from human tissues, both normal (tonsil, lung, kidney) and neoplastic (melanoma, Wilms' tumor); similar effects have been shown for suspensions of cells cultured from these tissues. Adsorption of antibody on monkey heart cell does not remove all of the cytotoxic antibody for human tonsil, and adsorption of the cytotoxic antibody upon suspensions of normal human tonsil, or monkey kidney, does not seem to remove the cytotoxic activity against the established monkey heart cell. Furthermore, studies of antibody-combining capacity, by cells and by cell extracts, also reveal the complexity of antigens involved.

It is apparent that considerably further study is required before any conclusions can be drawn. The purpose of this communication is to report a simple technique for measurement of cytotoxic antibody by means of which the relationship among continuously propagating cells may be investigated and, through this, the question of the use in man of vaccines prepared from such cells can be dealt with further.

JONAS E. SALK
ELSIE N. WARD
Virus Research Laboratory, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

References and Notes

1. E. A. McCulloch and R. C. Parker, *Canadian Cancer Conference* (Academic Press, New York, 1957), p. 152.
2. J. E. Salk, *Am. J. Public Health* 47, 1 (1957); "Cellular Biology, Nucleic Acids and Viruses," *N.Y. Acad. Sci. Spec. Publ.* 5, 77 (1957).
3. We wish to acknowledge collaboration with L. J. Lewis, Francis Yurochko, Donald Wegemer, and Louise Boccella in related aspects of these studies that have not yet been published. This work was aided by a grant from the National Foundation for Infantile Paralysis.
4. L. L. Coriell *et al.*, *J. Immunol.*, in press.
5. R. Schrek and F. W. Preston, *Cancer Research* 17, 102 (1957).
6. J. E. Salk, J. S. Younger, E. N. Ward, *Am. J. Hyg.* 60, 214 (1954).

8 November 1957

Rate as Response Probability in Discrimination Learning

It has been argued that rate of responding is the only appropriate datum to a formulation of behavioral change in terms of response probability (*1*). It has also been shown that, under certain restrictions, rate is mathematically equivalent to response probability (*2*). The experiments reported in this paper were designed to evaluate response rate as it corresponds to specific probabilistic predictions.

In discrimination, the organism comes to respond primarily to one set of stimuli (S) which are the occasion for reinforcement, or reward, and not to another set (S') for which responding is never reinforced. This study is concerned with the forms of S and S' response curves when the probabilities of sampling, or perceiving, stimulus elements in S and S', θ_1 and θ_2, respectively, vary from equality to a considerable inequality. Response frequency is known to be quite sensitive to differences in the manner of reinforcement. Consequently, two conditions of reinforcement known to produce marked differences in response rate were employed to determine the extent to which the forms of the curves predicted on the basis of stimulus control are distorted or overriden by the effects of such reinforcement contingencies.

From a discrimination model (*3*) developed from the Estes-Burke statistical learning theory (*4*), one predicts that the S and S' response curves approach their asymptotes monotonically when the sampling probabilities or θ values are equal. When θ_1 is larger than θ_2, the S curve accelerates more rapidly than is the case in the equal θ condition, and the S' curve may increase to a "peak" before it declines to a lower asymptote.

In experimental groups I and III, θ values were contrived to be equal through the expedient of setting an equal number of experimentally manipulated stimulus elements in S and S'. In groups II and IV, six times as many elements were assigned to S' as to S; hence, for these groups, $\theta_2 = \theta_1/6$. Five subjects were run individually in each of the four groups. The subject was required to pull a Lindsley manipulandum (*5*) for points on a counter as a series of patterns of lights were presented to him. Each pattern, composed of subsets of ten jewel lights mounted in two rows of five lights each, was presented for 1 minute. The subject was instructed to try for a maximum score on the counter at the same time he was trying to determine the principal defining S patterns. The only other room illumination was supplied by a blue 7-watt bulb mounted above the counter: white noise was piped in through a speaker and headphones for masking purposes.

Groups I and II were placed on a 10/1 variable-ratio schedule of reinforcement—that is, subjects in these groups were awarded one point for every tenth response, on the average, made in the presence of S patterns. Figure 1 shows the mean frequency of response per stimulus pattern. In the second experiment, subjects in groups III and IV were placed on a 30-sec fixed-interval schedule of reinforcement—that is, they were awarded a point for the first response made after each 30 sec interval during S presentations. Only 25 S and 25 S' patterns were presented in these latter groups, as opposed to 30 S and 30 S' presentations in the ratio groups. As is shown in Fig. 2, the over-all mean response rates are considerably lower in the interval groups. This is in agreement with previous studies of the effects of schedules of reinforcement upon rate of response. It should be noted that, despite the large differences in rates obtained under the different schedules, the predicted ordinal positions of the curves are invariant and as predicted insofar as the more difficult discriminations are not far advanced. The S' curves under

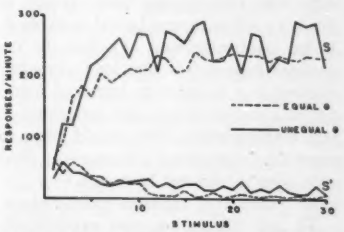

Fig. 1. Rates of responding in discrimination learning under a 10/1 variable ratio schedule of reinforcement.

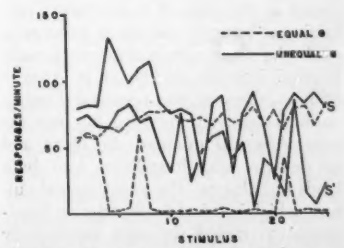

Fig. 2. Rates of responding in discrimination learning under a 30-sec fixed-interval schedule of reinforcement.

the unequal 0 conditions are some distance from their asymptotes, but their relative positions are the same under both conditions of reinforcement.

Different schedules of reinforcement thus produce large differences in rate and temporal patterning of response. It seems safe to conclude, however, that despite these effects, rate of response is a sensitive datum for the evaluation of probabilistic predictions. This is of importance, for it makes possible direct extensions of current learning models to more general experimental conditions than have hitherto been employed.

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Food or Training in Paramecium?

From behavioral and biological studies of the protozoan *Paramecium aurelia*, we hope to get generalizable information about relations between intracellular dynamisms and behavior.

In a series of experiments I have investigated a response by which food-deprived *P. aurelia* can be induced to cling to the sides of a clean and sterile platinum wire after having been exposed to the wire when it was baited with food. It has been suggested (*1*) that the organisms' approach to the clean wire after training is a response to bacterial material that was previously left in the culture and nothing more. This would seem to mean that exposure of paramecia to food with wire would not have any very different effect from exposure to food alone.

To test this notion, two experiments were performed to investigate the effects of various amounts of wire presentation (*2*). In one experiment, a microdrop of bacterial suspension (food) was introduced at the *edge* of a depression containing a "hungry" culture of paramecia, while the clean wire was simultaneously lowered into the middle of it. After 8 minutes, the wire was removed. Control cultures received the food but not the wire. After 30 minutes, the clean and sterile wire was introduced into both kinds of cultures. The experimental culture, which had had food and wire simultaneously, ringed the wire significantly more than did the controls ($p < 0.02$).

In another experiment, two wires were used, one 3 times the diameter of the other. On the larger wire, 3 times as many wipes of bacteria were applied as on the smaller, but the smaller wire was immersed in the paramecium culture 3 times as often, with shorter time intervals between immersions. Total duration of training period, amount of food, and area of wire exposed were equated for both groups, but the time of exposure to wire was 3 times as long in one group as in the other. The cultures which had longer exposure gave the wire-clinging response on tests, while the large-wire, shorter-exposure group did not noticeably exceed zero. For the difference between the groups, p was less than 0.01.

In all experiments, "trained" cultures have been routinely stirred up by rotation of the slide before placement on the microscope stage for final tests. Yet, when the wire is lowered, paramecia come to it. The response, in a good culture, is a slow and direct swoop toward the wire, different from any other behavior we have observed.

A response of lying motionless at the bottom seems to be built into the organism. When isolations are being made with a micropipette, many paramecia settle motionless to the bottom of the depression when the pipette is reintroduced. In "training" experiments, this lying down usually appears by the fifth descent of the wire and can be elicited as readily by a clean wire as by one which is baited with food. The response of actually clinging to the side of a clean wire, or remaining motionless in a limited area, is quite unusual.

If modification of behavior is due to presence of carbon dioxide or of bacterial food, and only to this, then change in training schedules (*3*) or in life-history (*4*), or from light to darkness (*5*), with food reinforcement administered similarly throughout, should affect strength of response only to the extent of chance variability, but the differences were found to be highly significant statistically.

We have tried to repeat Jensen's experiment with paramecia in the following way. We used media and bacteria on which paramecia were being satisfactorily maintained at the time, since a strain of, say, *Aerobacter areogenes* on which satisfactory cultures of *P. aurelia* have been bred for some time may suddenly become inadequate or even lethal (*6*). One drop of a suspension of bacteria in medium was added to a moderately food-deprived culture of paramecia such as we usually use in training experiments. To a matched culture, a drop of distilled water was added. A drop from each culture, was placed on a bacteriological slide, with a space of about 1 mm between the two drops. The two drops of paramecium culture were joined by drawing a narrow bridge of fluid between them. In one case, the bridge was drawn from the clear to the bacteria-clouded drop. In the other case, the bridge was drawn in the opposite direction. Fluid from each drop diffused into the other, forming clearly discernible phases of bacterial dilution.

When the bridge was drawn from the clear drop to the cloudy one there were some 48 paramecia in each drop. As time passed, the feeding paramecia slowed down, but at no time were any entirely motionless. After 1 hour, there were 21 animals in the cloudy side; 74 in the originally clear side, which by now showed a large infusion of bacteria; and some three paramecia in the bridge between the drops. This difference, which is opposite to what Jensen found, is significant beyond the 0.001 level of confidence.

When the bridge was drawn from the cloudy drop to the clear one, 25 paramecia were in each drop, exactly as Jensen reported. Again, no animals were motionless, but activity decreased with feeding. At the end of 1 hour, there were 31 paramecia (one in fission) in the cloudy side and 19 in the originally clear side. This difference is not statistically significant. Other, previous efforts to repeat Jensen's experiment had also yielded differences either not significant or in the direction opposite to that of his report. No doubt this can be explained by differences in procedure or in the condition of paramecia or bacteria, or both, that were used.

Our results conform well with the known fact that sufficiently dilute acid such as carbon dioxide or acetic acid will induce congregation of paramecia, while higher concentrations will repel them (*7*), response being made to monovalent, but apparently not to divalent or trivalent, cations (*8*). A rich suspension of bacteria lowers pH. The paramecia probably collected in those areas which offered the most nearly optimal pH conditions, always near the bridge between the drops.

Of course, in Jensen's experiments, many thousand times as many bacteria were used as in our behavioral work. Such a large quantitative difference has qualitatively different effects. Introduction of distilled water into a culture also has effects. Even the addition of a very small amount of water (as from condensation) into a culture growing rapidly in a depression slide will delay fission for hours.

In Jensen's experiment No. 1, bacteria were apparently introduced into distilled water from a platinum wire. The location and number of bacteria found after introduction into clear water cannot be compared with the location and number of bacteria similarly introduced into a thick culture of actively moving and feeding paramecia; (the amount of steak found in a dish placed on the floor in an

empty room would be very different from the contents of the same dish with a hungry dog present). We even find differences in the location of different strains of our *Aerobacter aerogenes*. Some strains tend to drop to the lowest part of the depression, while others remain rather evenly dispersed in a growing spot culture of paramecia.

From all of the foregoing work, I conclude that Jensen, by briefly investigating the dispersion in distilled water of a single strain of the bacterium *Aerobacter aerogenes*, cannot account for results I have been able to achieve with the protozoan *Paramecium aurelia* by use of techniques and controls developed during a number of years of careful study.

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More on "Learning" in Paramecia

In a previous report (*1*) I suggested a mechanism, other than learning, to explain the results reported in 1952 by Gelber (*2*). In a current report (*3*), Gelber describes some additional experiments. The question is whether these and certain other results (*4*, *5*) are explicable in terms of the effects of bacterial concentrations. I do not subscribe to the view that the sole influence on the behavior of paramecia in Gelber's experiments is the number and distribution of bacteria introduced into the cultures by the reinforcement procedure. Instead, I suggest that in one instance (*2*) differential introduction of bacteria into cultures influenced behavior; that in certain other instances (*4*) changes in life-history and in light intensities probably influenced the reactivity of paramecia to equal bacterial concentrations; and that in one instance (*5*) both differential introduction of bacteria and differential reactivity were involved.

Explanation of the first of Gelber's newly reported experiments does not seem possible in terms of bacterial concentrations but requires consideration of a related influence on the behavior of paramecia. Jennings (*6*) has pointed out that products of the animal's respiratory metabolism, secreted while the paramecia remain in a certain area, may create an acid zone which will trap paramecia. Animals enter that zone freely but do not leave it. It seems quite possible that, in this experiment by Gelber, the animals in the "food plus needle" cultures became attached to the needle during the "training" period and created an acid zone which persisted when the needle was withdrawn and which influenced behavior of the paramecia during the later test. This phenomenon of paramecium-produced, movement-restricting acid zones has been encountered both with aggregates (*6*) and with individual paramecia (*7*). For this explanation to be plausible, a manipulation newly reported by Gelber must be considered. Gelber reports having routinely stirred cultures "by rotating the slide." She has said that the rotating motion involved is a movement most easily described as that used in twirling ice cubes in a tumbler. To determine the efficacy of this movement for mixing 0.3-ml droplets of culture fluid in depression slides, such droplets were manipulated and observed, attention being directed to the pattern of paramecia and sedimentation in the droplets. Vigorous movement was required to mix the fluid appreciably, and the fluid nearest the center and the bottom of the hemispherical depression—the very area into which Gelber's needle was placed—was particularly difficult to mix by this manipulation, even though angular rotation of the fluid occurred.

The results of the second experiment, newly reported, appear to be explicable in terms of the original mechanism—the effects of differential bacterial concentrations on behavior of paramecia. The possibility exists that the number of bacteria deposited in the cultures by the large needle, inserted a few times, and the number deposited by the small needle, inserted a larger number of times, are unequal. To test this possibility, Gelber's reinforcement procedures were carried out on two 0.3-ml pools of distilled water, the diameters of needles, number of wipes of bacteria, and time intervals being as described by her. The pools were individually homogenized—that is, they were expelled from sterile micropipettes a number of times—and then equal-sized samples were taken from the two pools and stained with crystal violet. Four counts of bacteria along the margin of each sample were made at a magnification of 970. Seventy percent more bacteria (totals of 560 versus 326) were counted in the sample from the pool that had been reinforced with the smaller needle, inserted the greater number of times. It seems likely that the two reinforcement procedures introduced different numbers of bacteria into the cultures and that this produced differential bacterial concentrations, thus producing the observed differences in behavior.

The third experiment reported by Gelber (*3*) is a modification of one performed by me (*1*). The fluid added to the experimental pool, however, was culture fluid rather than reinforcement fluid and was much less rich in bacteria. It is certainly true that the addition of a drop of reinforcement fluid introduces many times the number of bacteria that are introduced by adding a drop of culture fluid or by the swabbed-needle reinforcement procedure. However, it is suggested that the density of bacteria is the variable that influences the behavior of paramecia. There is no evidence that the pool to which rich reinforcement fluid is added, and which is then homogenized, and the small portion of a pool into which portion a needle, smeared with reinforcement fluid, is repeatedly inserted, do not have comparable densities of bacteria.

Curiously, Gelber accepts the principle upon which the experiment she repeated was based: "that sufficiently dilute acid . . . will induce congregation of paramecia" (*3*). The difference of opinion appears to be simply one of what density of bacteria will produce enough acid. It is my view that Gelber's baited-needle reinforcement procedure produces a density of bacteria sufficient to influence the behavior of paramecia. Gelber may feel otherwise, but she has presented no evidence in support of the contrary view.

Gelber (*3*) asserts that introduction of bacteria into clear water cannot be compared with their introduction into a thick culture of actively moving and feeding paramecia, and she suggests an analogy between bacteria and paramecia and a bowl of food and a hungry dog. The use of this analogy symbolizes what is perhaps the most basic difference of opinion between Gelber and me. Gelber freely applies to Protozoa concepts (reinforcement and approach response) and situations (food presentation) developed with higher metazoan animals. I feel that such application overestimates the sensory and motor capabilities of this organism. As Jennings has pointed out (*6*), a paramecium is not a voracious predator which sights and stalks its prey and food; it is a filter feeder which blunders into its food by chance. If analogies are necessary, a more apt one might be that of an earthworm which crawls and eats its way through the earth, blundering onto food-rich soil and avoiding light, heat, and dryness. Gelber's assertion loses its force when the blind, filter-feeding mode of life of paramecia is considered.

In summary, one can conclude that, by the presence of bacterial concentrations resulting from reinforcement procedures, the effect of bacterial concentrations on the behavior of paramecia, and the influence of paramecium-produced, movement-restricting acid zones, it is possible to account for the results

newly reported by Gelber. Experiments less amenable to alternative interpretation are needed to justify recourse to the concept of learning.

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9 October 1957

Enhancement of Goitrogenic Action of Propylthiouracil by Thyroxin

Previous studies in this laboratory (*1*, *2*) have shown consistently that the goitrogenic effect of propylthiouracil (PTU) could be enhanced by dried thyroid powder, administered concurrently over a specific range of dosage for long periods (8 to 18 months). This treatment also resulted in greatly enlarged pituitary glands. The antigoitrogenic effect of thyroid hormones, when administered over short periods, is of course well known and has been observed many times in this laboratory. Therefore, the increased goitrogenesis was unexpected. It was not clear whether the substance causing increased goitrogenesis which was present in the dried thyroid powder was thyroxin or some other material (*3*). It was also possible that a goitrogenic substance was present in Fox chow (*4*), our commercial laboratory ration. Iodide added by the supplier to the commercial ration could be expected to affect goitrogenesis.

Therefore an experiment was designed (*5*) to examine the effects of iodide and crystalline L-thyroxin (Na salt) (*6*) on the thyroids and pituitaries of PTU-treated rats. Male Wistar rats were fed either a standard chow diet or a semisynthetic diet of low iodide content (whole-wheat flour, 52 percent; soya bean flour, 22 percent; skim milk powder, 10 percent; beef fat, 10 percent; corn oil, 5 percent; cod liver oil, 1 percent) with or without a supplement of potassium iodide (1 mg/100 g of diet) and with or without a dietary supplement of crystalline L-thyroxin (2.5×10^{-2} mg/100 g of diet). Propylthiouracil (20 mg/100 g of diet) was added to all diets except the control. Sacrifice of the animals was begun 16 months after the start of the experiment. Table 1, experiment 1, shows the weights of the thyroid and pituitary glands, the statistical significance of the difference between average weights, and estimates of the thyrotrophin content of the pituitaries. The pituitaries were frozen on Dry Ice and stored in a Deep-Freeze for approximately 3 months (*7*).

The enhanced goitrogenesis occurred when crystalline L-thyroxin rather than dried thyroid was used as a supplement to the PTU diet. It also occurred when a semisynthetic diet of low iodine content rather than chow formed the basal diet, although the enhancement was less than it was with the "chow" diet. In this comparison, the relative importance of the diet itself and the supplement of thyroxin can only be assumed because no control group that was fed the low iodine diet and PTU was included in the experiment. The pituitaries of rats that had received the semisynthetic diet supplemented with PTU and thyroxin were also slightly smaller than those of the corresponding group that had been fed chow. The thyrotrophin content was less than that of the chow-PTU-thyroxin group, but it was greater than that of the chow-PTU group. When iodide was added to the semisynthetic diet (in an amount estimated to equal that in the chow), intermediate values were found for the weights of the thyroid glands, although the weights and thyrotrophin content of the pituitary glands were less than they were with either the chow or low-iodide diet. The presence of excess iodide apparently enhanced the goitrogenic effect of thyroxin in the dosage used here. The smaller size and lesser thyrotrophin content of the pituitary glands and the larger thyroids suggest an action directly on the thyroid gland. Because the amount of iodide added to the semisynthetic diet was similar to that in the laboratory ration, the results also indicate that laboratory chow may contain other substances which interfere with the thyroid-pituitary interrelationship.

Although the pituitaries were enlarged, in this experiment only one tumor of the pituitary was found in a rat which succumbed relatively soon after the experiment started. Previous experience had led us to expect a high incidence.

Previously, experiments using the same low-iodide diet only, the diet supplemented with thyroxin (5×10^{-2} mg/100 g), and the diet with thyroxin plus PTU (20 mg/100 g of diet) had been carried on over a period of 10 to 14 months (Table 1, experiment 2) (*8*). While the weights of glands are not comparable statistically to those of the first experiment, it is seen that the average weight of thyroids from the group fed the low-iodine diet only (group 5) is higher than that of thyroids from the control group fed chow (group 0). Animals fed the diet supplemented with thyroxin only

Table 1. Enhancement of the goitrogenic action of propylthiouracil by thyroxin. All values represent mean values. Organ weights and pituitary thyrotrophin (TSH) contents are expressed in milligrams per 100 grams of rat weight. The semisynthetic diet was low in iodine.

Group and diet	Initial No. of rats	*N*	Rat wt.	Pituitary	Thyroid	Pituitary TSH units
Experiment 1; duration, 16 months						
0; Controls, on chow	30	26	539	2.2	5.8	0.59
1; Chow, PTU	50	41	320	3.2	19.8	0.24
2; Chow, PTU, thyroxin	50	40	418	4.7	112.2	1.29
3; Semisynthetic diet, PTU, thyroxin	25	19	396	4.0	54.3	0.88
4; Semisynthetic diet, PTU, thyroxin, KI	25	19	463	3.2	85.3	0.43
Experiment 2; duration, 10 to 14 months						
5; Semisynthetic diet	15	8	424	2.5	11.3	—
6; Semisynthetic diet, thyroxin	15	8	427	2.5	5.7	—
7; Semisynthetic diet, PTU, thyroxin	20	11	445	2.8	14.8	—
*Experiment 1; t values**						
0 versus 1				16.01	4.99	8.09
0 versus 2				7.76	5.79	6.60
1 versus 2				8.09	4.16	7.18
1 versus 3				4.04	2.59	6.70
2 versus 3				(1.06)	(1.24)	2.97
2 versus 4				5.38	2.90	(1.27)
3 versus 4				4.86	(1.91)	(2.00)

* $t = (\bar{x}_1 - \bar{x}_2) \left\{ \frac{n_1 n_2 (n_1 + n_2 - 2)}{(n_1 + n_2) \Sigma x^2} \right\}^{\frac{1}{2}}$; *t*-values for which *P* is greater than 0.02 are in parentheses.

(group 6) had smaller thyroid glands than those which received the unsupplemented diet (group 5). No goitrogenesis occurred in the group receiving the diet with PTU plus twice the amount of thyroxin present in the diets of groups 2, 3, or 4. Thus the enhancement of goitrogenesis by thyroxin is dependent on dosage.

The enhancement by thyroxin of the goitrogenic effect of propylthiouracil might be based on a possible stimulating effect of thyroxin on the growth of cells in the thyroid itself (2). The pituitary or other controlling centers might also require small amounts of thyroxin for the production of humoral agents. It has been suggested that more than one thyroid stimulating hormone (TSH) of the pituitary exists and that these hormones are subject to different mechanisms and exert different effects on the growth of cells and on the production of hormones in the thyroid gland (9).

In these experiments there is no convincing evidence supporting one of these suggestions to the exclusion of the others. Numerous factors undoubtedly influence the size, production and release of hormones by the pituitary and by the thyroid. It seems clear that the pituitary-thyroid relationship is very complex and requires further study.

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3 September 1957

Oscillating Corticonuclear Dipole in the Basal Forebrain of the Cat

Comparison of the "spontaneous" electrical activity recorded concurrently from the hypothalamus and the surrounding basal nuclei of either cerebral hemisphere showed that all wave forms on any one record were accompanied by similar wave forms on all other records. The amplitudes of the wave forms showed continuous gradations from anterior to posterior, lateral to medial, and dorsal to ventral, suggesting the presence of potential gradients in an oscillating electric field. Extensive diathermic lesions in one half of the hypothalamus merely altered the wave forms of the activity in the necrotic region. Transection of the brain in the vicinity of the medial forebrain bundle decreased or abolished the activity. This result suggests that the electrical activity of each half of the subcortical basal forebrain is due to an oscillating field of extracellular current with the source of the electromotive force (e.m.f.) located outside the hypothalamus.

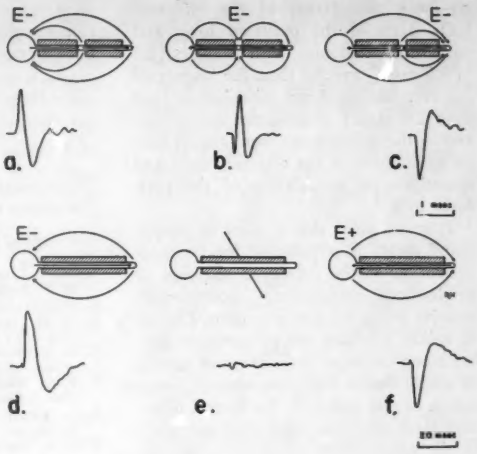

Fig. 1. Patterns of cellular current at the start (*a*, *d*), middle (*b*, *e*), and finish (*c*, *f*) of a propagated spike (*a*, *b*, *c*) and of a transient dipole field (*d*, *e*, *f*). The tracings represent the potentials that are recorded with a monopolar electrode placed at the somatodendritic end of each neuron (*a*, *d*), along the mid-portion of each axon (*b*, *e*), and at each axon tip (*c*, *f*). *E* indicates the site of the e.m.f.

To test this inference, the determination of the location and properties of the source of the e.m.f. was undertaken. Single-shock, bipolar electrical stimulation of the prepyriform cortex in the rhinencephalon resulted in the formation of a local potential (Fig. 1, *d*), which in a few milliseconds spread over the entire prepyriform cortex without change in its basic form. Simultaneously a mirror image potential (Fig. 1, *f*) spread through the ipsilateral basal nuclei. The nuclear wave was not propagated from the prepyriform cortex, since between the cortex and the nuclei lay an isopotential surface (Fig. 1, *e*). It is thought that this surface is best explained by the assumption that the two mirror image potentials are due to transient activation by the stimulus of a corticonuclear dipole. The e.m.f. of the dipole lies in the cortex, since direct nuclear stimulation did not activate it, and since minor damage to the prepyriform cortex caused concomitant decrease in both potentials, whereas administration of relatively more extensive trauma in the nuclear region had little or no effect on either potential.

The responses of the two potentials to anoxia, topical procaine applied to the prepyriform cortex, and intravenous injection of tubocurarine were identical with those of the first negative peak of the directly evoked neocortical potential (*1*), the second negative peak of which was not found in the paleocortex. This implies that the e.m.f. of the dipole field lies in the dendrites of the prepyriform cortex. During these procedures any change in the form, amplitude, and latency of the cortical potential was invariably accompanied by the same change in the mirror image potential. This means that when a net positive or negative charge is removed from the extracellular fluid in one part of the brain, the same net charge appears in another part. The hypothesis is proposed that in the activated state the prepyriform dendritic membranes produce an e.m.f., which drives current across the membranes into the cell bodies, down the efferent axons (for a distance of 4 to 8 mm), across the axon tips into the basal nuclei, and thence back to the dendrites through the extracellular fluid. This accounts for the negative wave of the dipole (Fig. 1, *d*); the positive wave is thought to be due to a rebound of the e.m.f. in the dendrites, causing current to flow in the opposite direction (Fig. 1, *f*). In some experiments there were three or more reversals in the form of a damped oscillation following a single stimulus.

The "spontaneous" electrical activities of the prepyriform cortex and basal nuclei were found to be mirror images, with the same distribution, gradients, phase shifts, and isopotentials as the prepyriform-evoked potential, and also with the same duration of wave forms. This evidence corroborates the hypothesis (*2*) that the e.m.f. of the electroencephalogram lies in dendritic plexuses, and shows that the electroencephalogram of the prepyriform cortex represents the activity of one pole of an oscillating corticonuclear dipole.

This dipole could be activated by sin-

gle-shock stimulation of the olfactory bulb, parts of the pyriform lobe, and parts of the thalamus, with latencies (2.5 to 8.0 msec) greater than the latency of the response to direct stimulation (less than 1.0 msec). Propagated spikes preceding the dipole wave were always seen on stimulation of the olfactory bulb and sometimes on stimulation of the pyriform lobe.

It seems clear that a burst of propagated spikes is responsible for transient activation of the dipole in response to single-shock stimulation; "spontaneous" activity might be due to continual trains of spikes reaching the prepyriform cortex along the same paths as spikes evoked by single shocks. Olfactory sensory stimulation evokes spikes in the lateral olfactory tract as well as oscillating potentials in the prepyriform cortex (*3*); pain induces the same oscillating potentials in that cortex (*4*). These findings are interpreted to mean that the e.m.f. of the dipole lies in the prepyriform cortex, but that the "controls" of the e.m.f. lie elsewhere in the rhinencephalon and thalamus.

The pattern of current postulated to occur during formation of the corticonuclear dipole is fundamentally similar to that thought to occur during saltatory conduction (*5*) (Fig. 1, *a*, *b*, *c*), but with this major difference: during saltatory conduction the site of e.m.f. moves to successive nodes of Ranvier, whereas during field conduction the site of the e.m.f. spreads in directions normal to the direction of conduction. During saltatory conduction in a nerve, the inflow and outflow of axonal current occurs through membrane areas of approximately equal size, but during field conduction the net somatodendritic current appears to pass through the axon tip. Since dendrites have more surface area than axons, the current density at the axonal tip may exceed the density at the dendritic surface. The possibility arises that the periaxonal *current density* may be "amplified" to levels capable of influencing surrounding neurons, in the same way as electrical stimuli delivered to the brain by means of electrodes (*6*). Certain anatomical peculiarities of cortical neurons lend credence to this possibility: the surface projections on the "feathered" dendrite (which would provide a large factor of amplification); myelinated axons purportedly without nodes of Ranvier (which would provide insulated conductors); and free endings (which in this view would not require a chemical transmitter for activation of surrounding cells).

The prepyriform cortex appears to be the site of an electromotive force capable of forming an oscillating current field in the basal forebrain nuclei. The control of the field appears to reside in structures adjacent to the prepyriform cortex. It is suggested that to the extent that rhinencephalically induced currents influence neuronal activity in the basal nuclei, a transfer of information can take place from the cortex to the nuclei without the mediation of propagated spikes (*7*).

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7. This investigation was supported by a fellowship (BF-6317-C) from the National Institutes of Health, U.S. Public Health Service.

4 October 1957

Phenology of Lilac Bloom in Montana

Studies of periodic biological phenomena in relation to the environment, often referred to as phenology, are being made throughout Montana in order to learn more about climate and its relation to agriculture. In the spring of 1956, the Montana Agricultural Experiment Station, in cooperation with the U.S. Weather Bureau and local garden clubs, began a survey of various stages of development of the common purple lilac (*1*). This plant was selected for observation because it is widely grown throughout the state and can be easily identified and because the timing of its various developmental stages appears to be dependent on the "thermal" environment. The "thermal" environment of the plant, as the term is used here, is a physiological concept. Although plant development increases with higher temperatures (within limits), the relation is by no means linear. Furthermore, other factors, such as radiation, wind, humidity, and so on, contribute to the rate of over-all development and to some other physiological responses of the plant. It is this total environmental complex, usually well represented by temperature measurements, which is designated "thermal" environment.

Questionnaire cards were sent to 327 Montana climatological observers by state climatologist R. A. Dightman, requesting information on the following three stages of floral development of the common purple lilac; date of first bloom, peak of full bloom, and final withering of the lilac bloom. The information requested was received from 123 weather observers. In addition, similar data on the lilac and other plants were reported by garden club members, mainly from the larger communities throughout the state.

Some plants that develop through their various stages of maturity without being greatly affected by the natural variations of photoperiod or soil moisture can be used as integrators of the "thermal" environment and thereby can serve as climatic indicators. Hence, indicator plants which are widely distributed and available for observation may be considered "measuring sticks" of *local* climatic differences.

This use of available plant indicators for purposes of learning more about the natural environment can prove to be of particular value to agriculture because local climates often determine success or failure in growing different varieties of agricultural crops.

Since weather observations are made only at widely scattered points, little is known about local climates on individual farms. Also, within similar climatic areas, (so designated on the basis of available weather information), considerable differences in plant development are often found because climatic variables not measured at the climatological stations—variables such as solar radiation, wind, humidity, and the daily course of temperature—are disregarded in the climatic classification. Because of the expense of measuring all important climatic elements and of increasing the density of the climatological network, the phenological approach to understanding regional and local climates may have an important role to play in climatology.

Phenological data are of value not only as climatic indicators; they can be utilized in many other ways. For example, observations on developmental stages of various agricultural crops serve as a basis for scheduling farm operations, even though the agricultural crops observed may not be well adapted as indicator plants. Phenological data can also help in revealing basic information about plant-environmental relationships, since weather effects are often closely linked to their concurrence with particular stages of crop development.

The lilac bloom survey conducted throughout Montana in the spring of 1956 has provided useful information about the climate and plant development in this state. The dates of bloom were plotted on maps, and "late" and "early" areas were determined. Statistical analysis of the information indicates that latitude and elevation were significantly correlated with dates of lilac bloom. It was found that the season was retarded about 1 day for every 20 miles

of northward distance. The bloom was also about 1 day later for every 100-foot increase in elevation in the mountainous areas.

As more information is accumulated in subsequent surveys, analyses will be made to determine the relation between weather measurements at the climatological stations and plant development.

Figure 1 shows the periods when lilacs came into bloom throughout Montana in the spring of 1956. In "early" areas, indicated by horizontal lines, lilacs bloomed before 20 May. Areas with no lines were intermediate, with bloom beginning between 20 and 25 May, and the areas of slanted lines were last, with the onset of bloom coming after 25 May. Due to the scarcity of reports from areas above 5000 feet and to the great influence of the irregular terrain at these altitudes, this initial analysis does not extend to higher elevations.

Two large early-blooming areas are shown on the map, one in the east-central part of the state and the other in the far western valleys. Earliest reports of bloom dates came from Hardin (elevation 2895 feet), in southeastern Montana. A number of reports of early bloom also came from the north-central part of the state, including locations in and near Great Falls and Highwood and the towns of Chinook and Dodson.

Lilacs bloomed late in the northern communities bordering on Canada, in the northeastern section near North Dakota, and in some of the mountain valleys of the western section. Latest reports of bloom dates came from Elliston (elevation 5075 feet), in west-central Montana.

Figure 2 shows the duration, in days, of the period between the beginning and the end of the lilac bloom. Lilacs remained in bloom less than 14 days in the areas where there are horizontal lines and more than 20 days in regions covered by slanted lines. This map tends to reflect the weather which occurred during the blooming period, and it could provide a basis for understanding relationships between weather and plant development.

For the state as a whole, it required an average of 7 days for the lilacs to advance from opening of first bloom to the date of peak of full bloom and 9 days to develop from peak of full bloom to the end of bloom. The highest station reporting lilac bloom was Lima, in southwestern Montana, with an elevation of 6265 feet, and the lowest station to report lilac bloom was Hinsdale, in the northeastern section, which has an elevation of 2170 feet.

A number of countries have well-organized phenological networks and are effectively utilizing such information in their agricultural planning. It is interesting to note that phenological observations have been made in Europe from the mid-18th century up to the present time, whereas very little has been done in the United States to obtain phenological information on a regional basis.

In 1957 phenological reports are being obtained from individual farmers throughout the state as well as from the climatological observers and garden club members who cooperated last year. Since lilacs are not available for observation purposes in some parts of Montana, an alternate indicator plant, the large common *Caragana* (Siberian pea), is also listed for this year's survey. The *Caragana*, a yellow flowering perennial, completes its various stages of bloom at about the same time as the lilac. Study of the additional reports now being received will permit greater detail and accuracy in the charting and statistical analyses of the phenological information.

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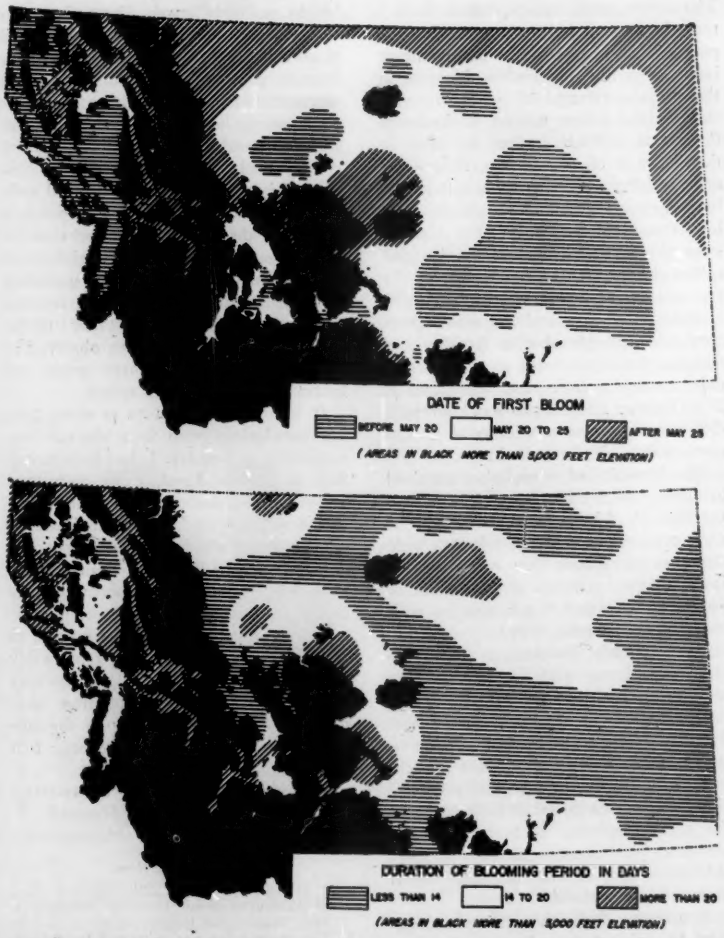

Fig. 1 (Top). Periods when lilacs came into bloom in Montana in 1956. Fig. 2 (Bottom). Duration of the period of bloom.

Note

1. This survey was made possible through the cooperation of R. A. Dightman, state climatologist, U.S. Weather Bureau, and of V. E. Iverson and H. N. Metcalf, Horticulture Department, Montana State College.

7 October 1957

Relation between Size of Neurons and Their Susceptibility to Discharge

Neurons in the central nervous system differ widely in the size of their cell bodies. Even in relatively homogeneous groups of cells, such as motor neurons, the differences in volume and surface area are considerable. The functional significance of these variations in size is not known. It is, of course, a well-established fact that the voltage required to

excite axons electrically increases as their diameter decreases (*1*). It does not follow, however, that large neurons can be more easily discharged synaptically than small ones. The situation, in fact, appears to be just the reverse, to judge from the studies on spinal reflexes described in this report (*2*).

The experiments were carried out on cats whose spinal cords had been transected just below the obex. Reflexes were elicited in lumbar ventral roots by electrical stimulation of dorsal roots or large nerve trunks (*3*). When shocks of sufficient strength were used, the response consisted of two phases (Fig. 1): a brief, relatively synchronous discharge of short latency, followed by rhythmical firing, sometimes lasting a second or more (*4*). In order to analyze the second phase of the reflex in detail, recordings were taken from fine filaments of ventral roots dissected under a low-power binocular microscope. In these it was possible to distinguish the individual impulses of single motor neurons discharging repetitively. As may be noted in Fig. 1, these impulses may differ considerably in amplitude. The amplitudes vary directly with the diameters of the fibers in which the impulses are conducted (*5*). It is assumed here that the diameter of axons is related to the size of their cell bodies. Large spikes, accordingly, will be taken to signify discharge of large motor neurons.

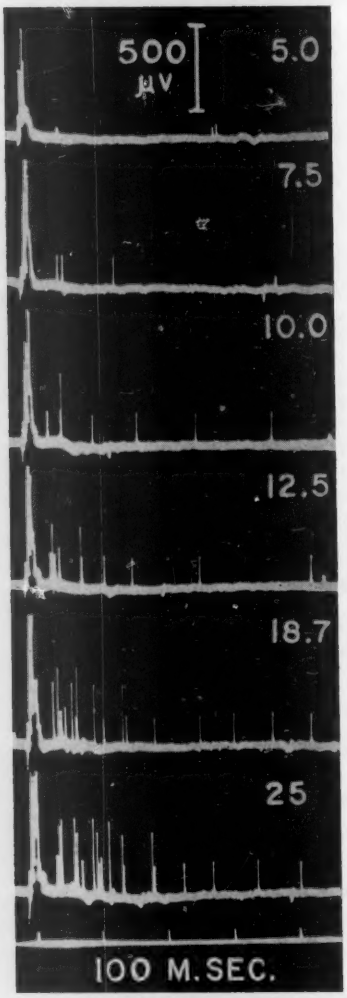

Fig 1. Reflex discharges recorded from a filament of the seventh lumber ventral root in response to stimulation of the ipsilateral sciatic nerve. Figures at the right of each tracing indicate the intensity of the stimulation, in volts. The initial deflection at the left of each tracing is the early discharge referred to in the text.

Figure 1 illustrates progressive changes in the late response recorded from a ventral root filament as the stimulus applied to the ipsilateral sciatic nerve was increased from 5.0 to 25 v. In the upper record the stimulus was well above threshold for the early reflex but was too weak to evoke the later discharge. The three small spikes shown in this record were probably spontaneous impulses in gamma or "small motor" fibers innervating muscle spindles. Increase in the stimulus strength to 7.5 v caused a single alpha motor neuron to discharge three times. With further increases in the intensity of stimulation, this motor neuron, identifiable by the amplitude of its spikes, responded with progressively longer trains of impulses. At a stimulus strength of 10.0 v, a second unit, with spikes about twice the amplitude of the first, made its appearance, thereafter discharging two, four, and five times in response to stronger shocks. A third and still larger unit appeared at 18.7 v, firing twice at this intensity and four times at 25 v. Further increases in shock strength did not bring any additional motor neurons into the late discharge.

The intensity of stimulation required to elicit prolonged repetitive discharges varied with the level of excitability of each preparation. At times it was only three to four times that necessary for monosynaptic reflexes. Recruitment of progressively larger motor neurons with increase in stimulus intensity was observed regularly. Discharges of slightly smaller neurons with stronger shocks were occasionally noted in single tracings but never as a regular occurrence. In general, units which differed most in spike amplitude differed most in the strength of stimulation necessary to discharge them. Even small differences in the spike amplitude of motor neurons, however, were accompanied by measurable differences in what might be called their reflex threshold.

It appears, then, that motor neurons may be graded according to the ease with which they may be discharged synaptically. At the upper end of the scale are the largest cells, requiring the most intense stimulation. Intermediate on the scale are the smaller, alpha motor neurons, requiring less intense stimulation but not discharging spontaneously. At the lower end of the scale are the "small motor" or gamma neurons innervating muscle spindles. In most recordings from ventral root filaments, these cells can be seen firing steadily without externally applied stimulation. This tendency to be continuously active is perhaps an indication that small cells are so susceptible to excitation that the spontaneous activity of the spinal cord is sufficient to keep them firing.

Although the discharge patterns recorded from different ventral root filaments varied, certain features were regularly observed. The most notable were recruitment of larger units and lengthening of the trains of discharge with stronger shocks; regularity in the rhythm of discharges in each train of impulses, with progressive decrease in their rate; and an inverse relationship between spike height and train length. These characteristics suggest that the excitatory process responsible for the discharge of motor neurons is an intense, prolonged firing of internuncial cells. This activity presumably reaches an early peak of intensity, from which it declines smoothly to resting level. At its maximum, the barrage of impulses from internuncial cells is apparently intense enough to produce repetitive discharges in motor neurons of all sizes. As the excitatory activity subsides, it falls below the levels necessary to discharge the larger cells but remains adequate to fire the smaller motor neurons. Hence the patterns observed in Fig. 1: short trains of large spikes and longer trains of smaller spikes.

It would be premature to draw definite conclusions from these observations, suggestive as they are. It has been shown that the reflex threshold of individual motor neurons varies with the amplitude of the spikes recorded from their axons. The extent to which these findings apply elsewhere in the nervous system remains to be determined. The properties of particular nerve cells are seldom unique except in degree. What little is known, in fact, suggests that they are remarkably alike. This being so, the hypothesis may be advanced for consideration that throughout the nervous system the susceptibility of neurons to discharge is a function of their size.

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National Institutes of Health, U.S. Public Health Service.
3. The stimuli were single square wave pulses of 20 μsec duration. Reflexes were recorded monophasically from cut ventral roots, usually the seventh lumbar or the first sacral. D-Tubocurarine chloride was administered to prevent reflex movements.
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23 September 1957

Infantile Experience and the Maturation of the Pituitary Adrenal Axis

It has previously been proposed (*1*) that repeated handling of the infant animal constitutes a stress situation and that experience in infancy with stress results in a greater ability of the organism to adapt to stress in adulthood. Although there have been numerous experiments which have shown that infantile experience affects adult behavior, there has been little work on the effects of infantile experience on developmental processes in the infant organism.

Jailer (*2*) reported that infant rats, when they were subjected to cold stress, failed to show adrenal ascorbic acid depletion prior to 16 days of age. At 16 days of age, a 19 percent depletion in adrenal ascorbic acid was found. Jailer (*3*) postulated that the pituitary of rats younger than 16 days released ACTH as rapidly as it was synthesized, so that, prior to the 16th day, there was no intracellular storage of ACTH to be liberated under stress. As a result, before 16 days of age, the animals were not able to respond to an acute stress with increased release of ACTH. Jailer further reasoned that chronic stress prior to 16 days of age should lead to facilitation of ACTH production and intracellular storage, resulting in increased liberation of the hormone in response to later acute stress. Since it has been postulated that handling in infancy is a stress, it would be expected, on the basis of Jailer's hypothesis, that rats that had been handled up to 16 days of age would liberate more ACTH than nonhandled rats when subjected to cold and would show greater adrenal ascorbic acid depletion. The experiment described in this report (*4*) was designed to investigate the effects of handling during infancy on ACTH release as measured by adrenal ascorbic acid depletion (*5*) in the 16-day-old rat.

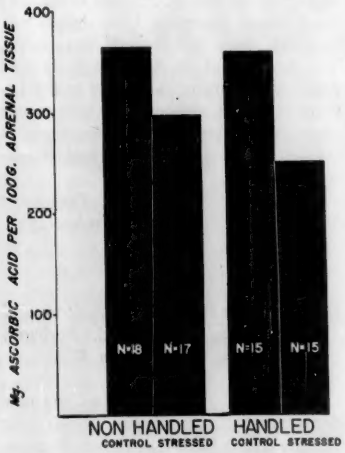

Fig. 1. Comparison of adrenal ascorbic acid concentration in the various groups of infant albino rats.

Sixty-five infant Sprague-Dawley-Holtzman albino rats were used as subjects. Thirty pups were handled from day 1 through day 15, and 35 were not handled in any manner during the first 15 days of life. The handling procedure was the same as that previously described (*6*). At 16 days of age the pups were randomly assigned to either the stress or control condition. There were thus four groups: (i) handled, nonstressed ($N = 15$); (ii) handled, stressed ($N = 15$); (iii) nonhandled, nonstressed ($N = 17$); and (iv) nonhandled, stressed ($N = 18$). The nonstressed animals were removed from their cages, killed by cervical spinal separation, and weighed. Their adrenals were removed, weighed on a 25-mg Roller-Smith balance, and analyzed for ascorbic acid content. The stressed animals were removed from their cages, placed in small individual compartments, and subjected to a cold stress of 5°C for 90 minutes. They were then killed, and their adrenals were removed, weighed, and assayed.

Adrenal ascorbic acid was assayed by a modification of the micro technique of Glick *et al.* (*7*). After being weighed, the adrenals were placed in a 15-ml ground-glass stoppered centrifuge tube and were thoroughly ground in 2 ml of 0.5 percent oxalic acid. Five milliliters of *N*-amyl alcohol were added to the tube; next were added 3 ml of a 4 mg percent aqueous solution of sodium 2,6-dichlorophenol indophenol dye. The tubes were then thoroughly shaken and centrifuged, the colored alcohol layer was removed, and its optical density was determined on the Beckman DU spectrophotometer at a wavelength of 546 mμ.

The handled and nonhandled groups showed essentially the same body weights and adrenal-weight/body-weight ratios at 16 days of age. In addition, the mean adrenal ascorbic content of the handled and nonhandled control groups was almost identical (nonhandled, nonstressed = 359 mg percent; handled, nonstressed = 365 mg percent). The handled, stressed animals showed a mean depletion of 109.73 mg percent and the nonhandled-stressed group, a mean depletion of 73.05 mg percent (Fig. 1). Thus, the handled animals showed 36.68 mg percent greater depletion, a difference significant beyond the 0.025 level of confidence ($t = 2.42$, $P < 0.025$). In terms of percentage depletion, the nonhandled animals showed 20 percent depletion, corresponding to the 19 percent obtained by Jailer, whereas the handled animals had a depletion of 30 percent.

The results of this experiment tend to support both (i) the hypothesis that infantile handling constitutes stress and (ii) Jailer's hypothesis concerning the effects of chronic stress on the facilitation of ACTH production in the infant animal. It should be noted that whereas Jailer's 16-day animals and our nonhandled animals showed only a 20 percent depletion, the 30 percent depletion exhibited by the handled animals in this study closely resembles the adult response to stress, which has been reported to be between 30 percent and 60 percent depletion (*8*). The question remains whether these results indicate greater intracellular storage, which results in more ACTH liberation at 16 days of age, or more rapid maturation of the pituitary adrenal axis. Preliminary results obtained in our laboratory indicate that handled infant rats respond to cold stress with increased ACTH release earlier than 16 days; this indicates that handling leads to more rapid maturation of the pituitary adrenal axis.

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26 September 1957

Book Reviews

The Organisation of Science in England. D. S. L. Cardwell. Heinemann, London, 1957, ix + 204 pp. 18s.

At a time when many nations are giving increased attention to the development of an adequate supply of well-trained applied scientists, Cardwell has supplied a well-documented and highly relevant case history of the development of a class of professional scientists in England. The telling of this story provides an opportunity for analyzing the developments of education in applied science in England, and for comparing those developments with parallel ones on the Continent.

Formal training in applied science was late in getting started in England. The Ecole Polytechnique was established nearly a century before anything comparable existed in England, and the great technological schools of Germany and Switzerland were frequently cited models in efforts to improve science education in England. There were, however, antecedents to the great growth of science at Cambridge, the founding of Imperial College, and the development of other now prominent centers of technological education. Cardwell gives some of the antecedent and parallel developments from the 18th century into the 20th: the Mechanics Institutes, the changing character of the universities, the origin and course of development of the Cambridge Natural Science Tripos, the founding of University and Kings Colleges in London and the University of London, and other significant events such as the impact of the Great Exhibition of 1851 and the later establishment of the Exhibition Fellowships.

These individual histories are used to document two major themes which run throughout the book. One is the argument that to have a flourishing scientific industry requires the existence of a class of professional scientists, and that to have a class of professional scientists requires both an educational system designed to train them and an adequate number of positions in which their vocation can be practiced. An organized system of technical education provides the solution to this apparent circle. It offers professional training. It also provides jobs for those who have been trained. Only after a sufficient number of teaching positions become available can industry begin to employ scientists, either by taking some from teaching posts or by engaging new graduates.

This is the major theme of the book, and it provides the framework for considering individual developments and comparing English with Continental experience. For example, when the International Exhibition of 1862 was held in London, there was much enthusiasm over Perkins' recent discovery of mauve. The official handbook of the exhibition promised, ". . . we shall soon become the great colour exporting country. . . ." The promise failed of fulfillment. Seventeen years later, Germany had 17 color works to England's five, and was producing coal tar colors of over four times the value of those manufactured in England. True enough, England was exporting, but primarily coal and coal tar rather than the finished dyes. Germany's leap ahead was attributed to the existence of a group of professional chemists, something England did not have.

The second recurring theme is the still fresh problem of the merits of specialization in education. Cardwell gives the arguments, pro and con, of many of the leading British scientists of the past century, and shows the relations between these arguments and the developing aspects of technological education. It is on this topic that the author closes. The achievement of professional science he recognizes as a desirable advance in social organization, but the high degree of specialization that now characterizes English education, even in the later secondary years, may well, he contends, hinder the progress of science itself by increasing the difficulty of communication and cross-fertilization among the interdependent branches of science.

Appropriately, the publisher classifies this work in the field of sociology. It is a thoughtful, useful contribution to the sociology of science.

DAEL WOLFLE
American Association for the Advancement of Science

The Hypercircle in Mathematical Physics. A method for the approximate solution of boundary value problems. J. L. Synge. Cambridge University Press, Cambridge, 1957 (order from Cambridge University Press, New York). x + 424 pp. Illus. $13.50.

One of the more beautiful *objets d'art* in mathematics is surely that of Hilbert space. Here geometry and analysis meet and enrich each other. It comes as somewhat of a shock to realize, under J. L. Synge's prodding, that one of the possible avenues wherein geometry could help in analysis has simply not been used. The chain—Euclidean concept to Hilbert space to analysis—has not been exploited. To be sure, the concept of distance has traveled this road. But the concepts of the plane, the sphere, the circle, and so on, have not.

This book undertakes to remedy this situation. Various geometrical constructs with which we are familiar in three-dimensional space are generalized to the infinite number of dimensions of Hilbert space. The insight, which comes from having a geometrical understanding, automatically suggests theorems and their proofs. In particular, an application to problems of boundary values suggests itself. In these geometrical terms, a boundary-value problem resolves itself into finding the intersection between the subspace composed of functions which satisfy the differential equation involved and the subspace composed of functions which satisfy the boundary conditions. For example, in electrostatics, upper and lower bounds to the capacity can be found, and a method of successive approximations can be set up.

The book is a model of clarity. The author starts slowly, reviews often, and gives many examples. One should not, however, think that it reads like a novel. The reader has to do some work too! Applications are made mostly to the Laplace equation, although the biharmonic equation, as well as the equations of acoustics, electromagnetism, and elasticity, is treated.

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Handbuch der Physik. vol. 32, *Structural Research.* S. Flügge, Ed. Springer, Berlin, 1957. 663 pp. Illus. $27.50.

Perhaps no other volume of the new *Encyclopedia of Physics* shows the changes which have taken place in physical research so clearly as does the volume on structural research. Even in the second edition (1933), the classical article by P. P. Ewald was barely 200

pages long and was just a portion of the volume on x-rays. The new volume, with indexes, has 663 pages!

The volume consists of monographs on "The Experimental Methods to Determine the Crystalline Structure by X-rays," by Gerard von Eller and André Guinier (Paris) (in French); "The Theoretical Principles of Structural Research by X-rays," by J. Bouman (Delft) (in English); "The Investigation of the Structure of Liquids and Amorphous Substances by Means of X-ray Diffraction," by Gerard Fournet of Paris (in French); "The Size of Particles and Lattice Defects," by W. W. Beeman, P. Kaesberg, and J. W. Anderegg (University of Wisconsin) and M. B. Webb (General Electric Research Laboratories) (in English); "Electron Interferences," by H. Raether (University of Hamburg) (in German); and "Neutron Diffraction and Interference," by R. Ringo (Argonne National Laboratory) (in English). The large amount of information on neutron diffraction now available did not exist at the time of publication of the second edition. The interferences from liquids and electron diffraction were briefly mentioned in two places; now each of these subjects forms the background for a detailed monograph.

The level of the book is entirely different from that of Ewald's. Whereas Ewald's book was written in such a way that it could be given to the beginning graduate student as an introduction to structural investigations with x-rays, the monographs in this volume are written for more advanced workers, and the bibliography takes into account only investigations of recent years. There are brief references, in the article by Bouman on theoretical principles of structural research by x-rays, to the elementary theory of diffraction, but otherwise most of the references deal with papers which have come out since the 1933 handbook appeared. This is quite justifiable in view of the fact that there is a large amount of material in the structure reports, which are now edited by the crystallographic societies.

One might feel that Bouman's article should really be the first one in the volume, for it lays the theoretical foundation, giving a detailed discussion of space groups, which is necessary for understanding of the experimental determinations that are discussed by Von Eller and Guinier.

The article by Von Eller and Guinier is quite complete; altogether, this volume is the only one in which all this information could be found, with the exception perhaps of Guinier's own book, *Theorie et technique de la radiocristallographie* (in French). The arrangement in the present text is sufficiently different to make the reading stimulating even if one is familiar with the former volume. The standard methods of Fourier analysis are discussed, as is the method of x-rac used by Pepinsky. The latter method seems to have been treated too briefly, for it is so far superior to anything that is otherwise available. The detailed discussion of the phase problem, by Bouman, will be welcomed by all workers in the field, as will be the discussions that follow of the various methods which have been used to solve this problem.

The article by Fournet on the structure of liquids and amorphous substances is perhaps the most complete monograph on the subject in existence at the present time.

The article by Beeman, Kaesberg, Anderegg, and Webb is divided into two subsections, one on the effect of particle size and the other on lattice defects. The latter, in particular, will be of great interest at the present time, now that imperfections in crystals have been studied so widely and have been recognized to be of such importance in many fields of solid-state physics. The last few paragraphs of this chapter, on x-ray microscopy and microbeam experiments, will be of interest to the investigator who is concerned with thin layers. On combining this information with the information supplied by Raether in his chapter on electron diffraction, one gains a good insight into what can be done nowadays with a combination of various diffraction methods. Some of the figures in Raether's article, in particular, are very beautiful. The detailed discussion of applications to electrolytically polished metal surfaces and to the structure of mechanically polished surfaces will be of great interest not only to the physicist but also to the engineer, and so will be the chapter on thin layers and their structure. This monograph closes with a brief description of the diffraction of electron waves, which have become more useful in recent years. The complete discussion of all the problems which are involved in neutron diffraction, now that reactors are becoming widely used all over the world, is of great importance. The advantages and disadvantages of the methods are discussed in detail; the discussion covers not only simple diffraction theory but also the various techniques which have to be used for interpretation and the experimental techniques which are necessary to get monochromatic neutron beams, as well as good detectors.

This is a very valuable book and will be indispensable not only to the physicist and physical chemist but also to the biologist who wants to learn more about the structure of materials. If I have one criticism, it is that there is, unfortunately, no really good index; the present one does not do justice to the amount of material which is actually available in the volume itself.

K. Lark-Horovitz
Purdue University

Economic Backwardness and Economic Growth. Studies in the theory of economic development. Harvey Leibenstein. Wiley, New York; Chapman & Hall, London, 1957. xiv + 295 pp. Illus. $6.75.

This book employs the tools of traditional economic theory to produce an abstract analysis of economic backwardness and economic growth. The central thesis consists of two parts: (i) Economic backwardness involves a condition of quasi-stable equilibrium such that any small growth in per capita income sets up forces, such as population growth, which operate to reduce per capita income and reverse the initial growth. (ii) In order to achieve sustained growth, the initial impetus to growth must exceed some critical magnitude necessary to overcome the reversing effect of the income-reducing forces.

This thesis involves much more than the obvious statement that, in order to raise per capita income, production must outrun population growth. On the one hand, the possible forces operating to reverse growth include not only population increase stimulated by higher incomes but also overconsumption, the exhaustion of particular limited resources, and institutional rigidities. On the other hand, these forces are of a limited magnitude, so that an initial growth above some critical rate will not be reversed but will tend to lead to further growth.

Possible patterns of quasi-stable equilibrium are examined analytically and used to explain some of the known characteristics of less-developed countries. The minimum effort necessary for sustained growth is considered analytically, and abstract models for growth are developed. Finally, an analysis is made of rates of population growth, of investment, and of appropriate investment policies.

The central theme of the book presents a promising hypothesis to be tested, and the detailed analysis constitutes useful pioneering in a field that is underdeveloped. At the same time, the analysis is likely to leave the reader with a sense of unreality. There is no evidence that the author has had any actual experience with underdeveloped countries. The application of market analysis to countries

such as India and Pakistan, where more than two-thirds of production is for communal use and lies outside the market; the neglect of the community development programs which are proving so successful in so many of the developing countries; the treatment of increased capital investment per capita as the determinant of per capita growth in income; the absence of any discussions of the role of development planning; and the exclusion of the balance-of-external-payments problem, which so seriously plagues most countries which are seeking more rapid development—all these aspects of Leibenstein's book indicate how partial the analysis is and how little it grapples with the real problems of economic growth, however successful it may be in diagnosing economic stagnation.

GARDINER C. MEANS
Committee for Economic Development

A Frontal Section Anatomy of the Head and Neck. Otto F. Kampmeier, Arthur R. Cooper, Thomas S. Jones. University of Illinois Press, Urbana, 1957. xii + 25 plates. $15.

The authors have prepared a clear, accurate, and well-labeled atlas showing the frontal-section anatomy of the head and neck. This should be a useful reference book for surgeons and others concerned with the detailed topographic anatomy of the regions dealt with. It shows the anatomy of the anterior faces of 20 frontal or coronal sections through the head and neck to the level of the cricoid cartilage and seventh cervical vertebra. The original sections, each about 1 cm thick and evenly spaced, were cut fairly symmetrically through a young adult negro specimen.

The plates are natural size. In their preparation, photographic enlargements of the sections were reworked and clarified by author-artist Tom Jones. Bones are colored with a yellow overtone, but other structures are uncolored. The various other anatomical structures—nerves, vessels, muscles, and so on—are clearly depicted, and the labeling is quite complete. Except for the temporal fascia, however, fascial planes of the head and neck were ignored. In addition to the 20 frontal sections, there are helpful reconstructions showing the front and side views of the skull, a midsagittal view, and lateral views of the arteries and veins.

The introductory pages include notes on the preparation of the sections and plates and historical notes on the section approach to anatomy, with special concern for frontal sections.

W. T. DEMPSTER
University of Michigan

Quelques Problèmes de Chimie Minérale. Rapports et discussions publiés par les Secretaires du Conseil sous les auspices du Comité Scientifique de l'Institut. R. Stoops, Ed. Institut International de Chimie Solvay, Brussels, 1957. 544 pp. Illus. F. 590, paper; F. 675, cloth.

This book contains 12 papers dealing with problems in modern inorganic chemistry, presented at the 10th Congress of Chemistry held at the University of Brussels in 1956 under the auspices of the Scientific Committee of the Solvay International Institute of Chemistry. The value of the papers is enhanced by the inclusion of detailed discussion. Five of the papers are in French, and seven, in English. Much of the discussion is also in English. For those interested in the modern phases of inorganic chemistry, this published work should be extremely valuable.

The papers, presented by leading authorities from France, England, Denmark, the United States, and Sweden, deal with such subjects as the complex compounds of the transition metals; physical chemistry of some nonstoichiometric phases; nonstoichiometric organic compounds; absorption spectra of complexes with unfilled *d*-shells; application of the screening theory of chemical reactions involving nonmetallic solids; applications of the crystal-field theory to problems of transition-metal chemistry; problems of solid-state chemistry; and the influence of adsorbed gases on the reactivity and stability of surface crystalline lattices.

Included in the book are pertinent features about the institute, the composition of its administrative committee, a list of those who participated in the congress (which includes members of the scientific committee, the members who gave the papers, invited members, various secretaries, and invited auditors), the speech of the president of the institute, the banquet address of the president of the administrative committee, the speech of the president of the congress, and the closing speech.

RALEIGH GILCHRIST
National Bureau of Standards

The Galactic Novae. Cecilia Payne-Gaposchkin. North-Holland, Amsterdam; Interscience, New York, 1957. 336 pp. Illus. $8.50.

About four hundred years ago Tycho Brahe wrote, "all philosophers agree, and facts clearly prove it to be the case . . . that the heavens and the celestial bodies in the heavens are without increase or diminution, and that they undergo no alteration, either in number or in size or in light or in any other respect" [quoted by J. B. Irwin, *Sky and Telescope* **16**, 544 (1957)]. Yet, it was Tycho himself who, in 1572, observed in the constellation Cassiopeia one of the rare cataclysmic "alterations" in a star of our galaxy—a supernova explosion in which a previously unknown (and probably invisible) star suddenly blew off a large fraction of its mass with a velocity that must have been of the order of several thousand kilometers per second and that raised the apparent brightness of the star until it rivaled Venus and could be seen in full daylight. We have no knowledge of the brightness of the star before its outburst. But at the present time there is no star in the position of the supernova brighter than about the 18th magnitude. The decline from maximum brilliance to the present postnova stage must have corresponded to at least 22 stellar magnitudes, or a factor of almost one billion. There is, however, in the region of the supernova a ragged-looking patch of turbulent nebulosity which emits not only visible light but also a large amount of long-wave radiation; it is, in fact, a conspicuous source of radio radiation. By analogy with the better known supernova of the year 1054—the Crab Nebula—it is reasonable to conclude that the radiation of the remnants of Tycho's supernova is, at least in part, of the "synchrotron" type.

While a supernova may appear in a single galaxy at a rate of one in several hundred years, the less spectacular normal novae appear at a rate of several dozen per year. Such a nova may suddenly increase in brightness by a factor of about 10,000; and the velocity of the ejected gas (about 0.00001 of the mass of the star) is more moderate—of the order of a few hundred kilometers per second.

All types of novae are now believed to represent particular stages in the evolution of old and massive stars which have exhausted most of their nuclear energy sources and are in the process of readjusting themselves to the state of "white dwarfs," a process that must involve a drastic reduction in the mass of the star.

Cecilia Payne-Gaposchkin's new book is a comprehensive summary of everything that is now known about these stars. It describes and coordinates the observations made by hundreds of astronomers during the past nine hundred years, and it illustrates the enormous difference between the research methods of the astronomers and those of other scientists. The phenomenon of a nova is not only a relatively rare occurrence, it is also one of short duration. An individual astronomer may succeed in observing its brightness or its spectrum on only a few

nights, and it would be impossible for him to draw any far-reaching conclusions from his own work. It is only by piecing together the results obtained by many observers of many novae that their common properties and the correlations of these properties with other stellar data can be ascertained. A very useful compilation of this sort was published in 1942 by G. Cecchini and L. Gratton, under the title *Le Stelle Nuove* (Ulrico Hoepli, Milan, Italy). But much new information has become available during the past 15 years, and nearly all of our knowledge of the significance of the novae in the broad picture of cosmical evolution has been collected in the past ten years. Cecilia Payne-Gaposchkin states in her introduction that "the book will be obsolete by the time it is printed," and we agree with her that "this is a measure of the timeliness of the subject." However, I believe that only her last and, incidentally, most inspiring, chapter, on "Evolutionary and Theoretical Problems," is in danger of being soon out-dated. The rest of the book will very likely remain for a very long time, if not forever, a source of information concerning the observational data for all novae up to the middle of the present century.

There are eleven chapters: "Statistics of Galactic Novae," "Distribution of Galactic Novae," "The Spectra of Novae," "Galactic Novae, First Class Data," "Galactic Novae, Second Class Data," "Galactic Novae, Fragmentary Data," "The Symbiotic Novae," "The U Geminorum and Z Camelopardalis Stars," "The Supernovae," "Comparative Study of Spectral Development," and "Evolutionary and Theoretical Problems." Each chapter lists extensive bibliographies. There is a convenient general index of all the novae discussed in the various chapters (including a number of stars which are not usually regarded as novae but which have spectroscopic or photometric properties that resemble those of novae).

The number of light curves and other line drawings is fully adequate to illustrate the photometric properties of the various groups of novae, but the number of halftone reproductions of the spectra of novae is disappointingly small. Some of these reproductions are vertically widened enlargements (accomplished by means of a cylindrical lens or a swinging pendulum) of very narrow original spectra. This process of widening often introduces spurious features in the reproductions which look like spectral lines but which are merely widened images of specks and clumps of grains on the original photograph. Considerable caution must be exercised in the use of these enlargements. The reader may wish to consult, in addition to this book, the very complete atlas of spectra of Nova DQ Herculis of 1934, which was published in 1939 by F. J. M. Stratton and W. H. Manning of the University of Cambridge, and the sets of synthetic drawings by D. B. McLaughlin of the University of Michigan, which represent the typical development of a nova spectrum from its premaximum stage (when the brightness is 1.5 magnitude less than at maximum) until the spectrum is that of a diffuse nebula (when the brightness is 6.2 magnitudes less than at maximum). These drawings may be found in *Astrophysics: A Topical Symposium* [J. A. Hynek, Ed. (McGraw-Hill Astronomical Series, New York, 1951), pp. 135, 136] and in other publications.

OTTO STRUVE
University of California, Berkeley

United States Army in World War II. The Technical Services. *The Signal Corps: the Test* (December 1941 to July 1943). George Raynor Thompson, Dixie R. Harris, Pauline M. Oakes, and Dulany Terrett. Office of the Chief of Military History, Department of the Army, Washington, D.C., 1957 (order from Supt. of Documents, GPO, Washington 25). xv + xx + 621 pp. Illus. $4.50.

The Signal Corps: the Test is the second volume of the history of the Signal Corps in the recent war; it covers the period from December 1941 to July 1943. It was prepared by the Historical Division of the Signal Corps under the direction of its chief, George R. Thompson, as one of the volumes in the series entitled the *United States Army in World War II.*

The first volume related the struggle of the Signal Corps to maintain itself and to develop in the period between the two world wars. General Omar Bradley agreed with the men of the Signal Corps that "Although Congress can make a General, it takes communications to make him a Commander." But the Signal Corps was to create more than that. This volume deals with the development of sense receptors for the Army's physiology and the development of a nervous system for integration and mobilization of the global military organism.

The second volume begins with the attack on Pearl Harbor, and the incident is symbolic of the course of events for the next 18 months. The Japanese planes were "seen" by what radar there was in operation on Oahu, but the information center failed to realize the significance of what was on the radar screens. Later, at Manila, similar information failed to pass through the channels of Army command. Lack of trained personnel, lack of equipment, and misunderstanding of what the equipment could do were all factors contributing to these tragedies. Indeed, at the beginning of the war the Signal Corps was an organization whose manpower and budget ran behind that of the other services. Even as late as 1942 General Colton remarked that the Signal Corps was farther behind in meeting its objectives than the other services.

Yet, by 1943, the research for the major technical advances had been carried out and most of the advances were already in the production stage. The British cavity magnetron had been applied successfully to produce a much more accurate microwave radar. Armstrong's invention of frequency modulation had been successfully applied to mechanized warfare. At the end of World War I the Signal Corps catalog had included some 2500 items, but by June 1943 it included more than 70,000. Thousands of men were pouring through old and new training schools of the Signal Corps by 1943. A global network of communications had been set up for the Army command and for the Army Air Force. Radio relay gave flexibility to the networks, carrier added many more channels, and radio teletype increased the speed of flow of information.

These advances were achieved during a period of internal conflict at the highest levels of command. Was the Signal Corps to supply materiel from civilian industry, or was it to organize and maintain communications? The problem of Signal Corps growth within the Army Service Forces and the conflicting goals of development, supply, and operations were expressed in the struggle of the Chief Signal Officer to obtain control of Army communications. The book ends with his defeat and retirement, but the authors point out that others were to reap the harvest of what he had sown.

W. JAMES KING
Smithsonian Institution

New Books

Biochemistry and Human Metabolism. Burnham S. Walker, William C. Boyd, Isaac Asimov. Williams & Wilkins, Baltimore, ed. 3, 1957. 944 pp. $12.

A Handbook of Animal Physiology. E. M. Pantelouris. Baillière, Tindall and Cox, London, 1957 (order from Williams & Wilkins, Baltimore). 263 pp. $6.25.

The Life, Work and Times of Charles Turner Thackrah, Surgeon and Apothecary of Leeds (1795–1833). A. Meiklejohn. Livingstone, Edinburgh, Scotland, 1957 (order from Williams & Wilkins, Baltimore). 238 pp. $6.

Cerebral Lipidoses. A symposium. J. N. Cumins, Ed. Thomas, Springfield, Ill., 1957. 222 pp. $8.50.

Meetings and Societies

Theoretical Reactor Physics

A conference on theoretical reactor physics was held 23 to 25 Sept. 1957, in Sun Valley, Idaho. This conference, which also served as the fall meeting of the Reactor Physics Planning Group (an advisory body to the U.S. Atomic Energy Commission), was sponsored by the Atomic Energy Division of Phillips Petroleum Company and the Idaho Operations Office of the Atomic Energy Commission.

Twenty-six invited papers were presented at the conference; those presented on 23 September were devoted to nuclear physics, those on 24 September, to reactor statics, and those on 25 September, to reactor kinetics.

Almost 100 men were present for part or all of the meetings. There were representatives from the Atomic Energy Commission, Argonne National Laboratory, Atomics International, Atomic Power Development Associates, Inc., Brookhaven National Laboratory, California Institute of Technology, E. I. DuPont De Nemours and Company, General Atomics, General Electric Company, the Knolls Atomic Power Laboratory, Los Alamos Scientific Laboratory, the A.E.C. Computing Center at New York University, Oak Ridge National Laboratory, Phillips Petroleum Company, Ramo-Wooldridge Corporation, the Rand Corporation, the University of California Radiation Laboratory (Livermore), and the Westinghouse Atomic Power Division.

Sessions were held in Sun Valley's Holiday Hut each morning and evening; the afternoons were left free in order that the conferees might participate in Sun Valley's extensive sports program or explore the surrounding countryside.

The first session was opened by W. B. Lewis (Phillips Petroleum Company), who welcomed the members of the conference on behalf of the company and of the Idaho Operations Office of the Atomic Energy Commission. He then turned the meeting over to A. M. Weinberg (Oak Ridge National Laboratory), who introduced the topic for the day and presided over the two sessions.

The following papers were presented: "Nuclear reactions in stars and supernovae," W. A. Fowler (California Institute of Technology); "Present status of experimental neutron cross sections," D. J. Hughes (Brookhaven National Laboratory); "Wigner-Eisenbud multilevel formalism," C. W. Reich (Phillips); "Comparison of multilevel and single-level fits for U^{238}," R. G. Fluharty (Phillips); "Capture cross sections near 25 kev," R. L. Macklin, N. H. Lazar, and W. S. Lyno (Oak Ridge); "Recent developments in the calculation of resonance absorption probabilities," N. Corngold (Brookhaven); and "Some aspects of inelastic scattering," A. W. McReynolds and M. Nelkin (General Atomics), R. Carter (Westinghouse), and R. M. Brugger (Phillips).

The second day began with an introductory talk on reactor statics by B. I. Spinrad (Argonne National Laboratory) who presided over the morning and evening sessions. At these two sessions the following papers on reactor statics were presented: "Status of fast reactor theory," H. H. Hummell and W. Loewenstein (Argonne); "Convergence of S_n code and numerical integration of reactor kinetics equation," E. R. Cohen (Atomics International); "Theory of coupled reactors," R. Avery (Argonne); "Externally moderated reactors," G. Safonov (Rand); "Neutron thermalization," M. Nelkin (General Atomics); "Prompt excursions of a water cooled solid homogeneous reactor," N. Rostoker (General Atomics); "Resonance absorption in lumps: recent progress in analytical methods," J. Chernick (Atomics International); "Monte Carlo methods," R. Van Norton (New York University); and "Homogeneous System," N. Corngold (Brookhaven).

The last day of the conference was devoted to papers and discussion of reactor kinetics. The subject was introduced by M. M. Mills (University of California Radiation Laboratory), who presided over the morning and evening sessions. The following papers were presented: "Fast reactor kinetics," G. E. Hansen (Los Alamos); "Pulsed sources in fast assemblies," J. Bengston (University of California Radiation Laboratory); "Kinetics experiments, water boiler reactor," D. Hetrick (Atomics International); "An energy model for the initial behavior of SPERT I," G. W. Griffing and L. I. Deverall (Phillips); "Analysis of experiments involving reactor transients," A. F. Henry (Westinghouse Atomic Power Division); "Problems of theory and data, SPERT I," W. E. Nyer and S. G. Forbes (Phillips); and "Some problems in reactor stability," R. O. Brittan, J. Thie, and H. Greenspan (Argonne).

In addition to the formal papers presented, numerous discussions, both formal and informal, were held after the meetings and in the afternoons. Many conferees expressed the hope that this conference would be the first of an annual series to be held in southern Idaho.

P. W. HEALY

Atomic Energy Division, Phillips Petroleum Company, Idaho Falls, Idaho

Solid-State Phenomena in Electric Circuits

A symposium entitled "The Role of Solid State Phenomena in Electric Circuits" was held at the auditorium of the Engineering Societies Building in New York City, 23–25 April. This symposium was capably organized by the Microwave Research Institute of the Polytechnic Institute of Brooklyn, in cooperation with the Institute of Radio Engineers and with the cosponsorship of the Air Force Office of Scientific Research, the Signal Corps Engineering Laboratories, and the Office of Naval Research.

The welcoming addresses contained the following highlights: a prophecy that the explorations in solid-state physics have thus far barely scratched the surface, an affirmation of the military necessity for the United States to lead in electronics, and the disclosure that the Government sponsors of the research programs which maintain this leadership are gratified by the surprising productivity of research in areas in which initial investigations appeared to hold no practical interest.

Here are a few extracts from notes and sketches made at the symposium. The state of development of the devices and other details will be found in the proceedings of the symposium, which will be published in the early fall.

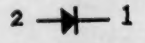
Two forms of a modulator or variable attenuator for microwaves, which look similar but function quite differently, were announced by A. F. Gibson and J. W. Granville of the Radar Research Establishment in England (Fig. 1). In both cases, a thin slab of germanium is inserted in a wave-guide to attenuate the flow of power. The attenuation of this thin germanium slab can be varied either by (i) varying the concentration of current carriers or by (ii) varying the mo-

bility of the current carriers. The population of minority carriers can be varied by means of an injecting contact at one end of the slab. In this case, the response time depends on the transit time of minority carriers across the slab, which is of the order of microseconds. The other method utilizes the fact that carrier mobility decreases with increasing electric field, and requires ohmic contacts at both ends of the slab. By the application of large amplitudes of voltage, the transmission of radiation is controlled. This method holds greater promise for high frequencies, because the response time is limited essentially by the dielectric relaxation time of the germanium (10^{-12} sec).

Although the Hall effect (Edmund Hall, of Harvard University) dates back to 1879, the recent interest in the III–V compound In Sb has brought to light several new applications. This compound yields a very large Hall voltage as a result of its unusually high mobility of electrons (67,000 cm²/volt sec at room temperature). E. W. Herold, of the Radio Corporation of America, mentioned a gyrator circuit which employs the Hall effect (Fig. 2). The distinctive feature of this circuit is that it is a four-terminal network for which the reciprocity canon does not hold. Two other applications cited by Herold were a wattmeter and modulator.

A novel phonograph pick-up that utilizes the magnetoresistance of In Sb was described by T. S. Moss of the Royal Aircraft Establishment, England. The resistance of a sample of In Sb can be increased as much as 19 times in a magnetic field, and by means of this effect, as shown in Fig. 3, small displacements of the sample can be translated into a detectable electrical signal.

Another device, a photomagnetic rectifier, was announced by Moss (Fig. 4). Rectification ratios of $10^4/1$ have been obtained with experimental units. The operation is explained here in terms of an *n*-type semiconducting sample. With current directed from terminals 1 to 2, the holes generated by the light are deflected by the magnetic field to the region bounded by sandblasted surfaces, which capture holes and thereby restrict current in the direction from 1 to 2. On the other hand, with current directed from 2 to 1, the holes are deflected to the region bounded by etched surfaces which have little influence on hole current. Therefore, the semiconducting sample (Fig. 4) acts as a rectifier with the direction of easy flow from 2 to 1, as indicated by the circuit symbol



H. Kroemer, of the Radio Corporation of America, proposed a fused silicon-germanium junction transistor, which utilizes the difference in energy gap between silicon and germanium to obtain a high emitter efficiency. The electronic

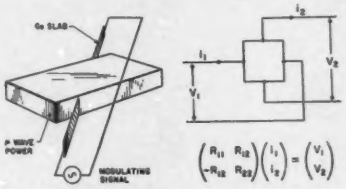


Fig. 1 (Left). Microwave modulator, or variable attenuator. Fig. 2. (Right). Schematic circuit diagram of the Hall effect gyrator. The Ohms law relation stated in matrix form indicates that reciprocity is violated.

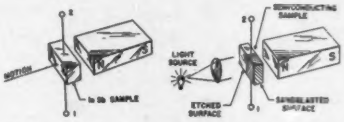


Fig. 3 (Left). Motion-sensing device employing magnetoresistance. Fig. 4 (Right). Photomagnetic rectifier.

Fig. 5 (Left). Electronic energy band diagram of a high-gain silicon-germanium alloy transistor. Fig. 6 (Right). Circuit diagram of a cryotron.

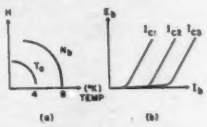


Fig. 7 (*a*) Critical temperature versus magnetic field. (*b*) Current-voltage characteristics.

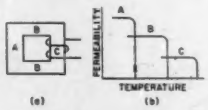


Fig. 8. High temperature inductor. (*a*) Schematic illustration. (*b*) Permeability versus temperature.

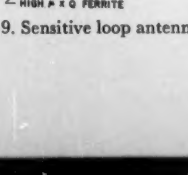


Fig. 9. Sensitive loop antenna.

energy band scheme for this device is sketched in Fig. 5. The emitter efficiency of a *p-n-p* transistor is the ratio of emitter hole current to the total emitter current. Therefore, the structure shown in Fig. 5 has a high emitter efficiency because the barrier for hole current, which flows in the valence band, is substantially smaller than the barrier for electron current, which flows in the conduction band.

It was pointed out that the cryostat has become a practical tool in many military applications. Among the devices which operate in cryostats are masers, transformers which operate both on direct current and alternating current, and cryotrons. Both M. Strandberg, of Massachusetts Institute of Technology, and J. O. Artman, of Harvard University, reported on solid-state maser amplifiers. Since these devices have been adequately treated elsewhere [J. Combrisson, A. Honig, C. H. Townes, *Compt. rend.* **242**, 245 (1956); N. Bloembergen, *Phys. Rev.* **104**, 324 (1956), J. P. Wittke, *Proc. I.R.E.* (*Inst. Radio Engrs.*) **45**, 291 (1957)], it should suffice to relate that they have already attained a twofold increase in radar sensitivity and have provided noise temperatures as low as 10°K.

H. O. McMahan, representing Arthur D. Little, Inc., pointed out that a transformer in which the secondary winding is a superconductor can transmit direct current as well as alternating current by virtue of the Meissner effect. The Meissner effect can be demonstrated by the following procedure: place a magnet on a lead plate and reduce the temperature below the critical temperature for lead (the temperature below which lead is a superconductor). As the temperature falls below the critical temperature, the magnet jumps up and floats in space above the plate. The explanation is that surface currents induced in the superconductor *completely* prevent the penetration of the magnetic field, and these induced currents do not damp out but persist indefinitely.

Both McMahan and Herold mentioned the cryotron (Fig. 6), a new solid-state amplifying device which operates in a cryostat at temperatures below 10°K and depends on the variations of the critical temperature of niobium and tantalum in a magnetic field (Fig. 7*a*). The current-voltage characteristics of the device are shown in Fig. 7*b*, and it may be seen that, in the language of the circuit engineer, the cryotron is a dual to the vacuum-tube triode. The resolving time of the cryotron depends on the ratio of the inductance of the cryotron to the resistance of the external circuitry. Switching speeds of 10^{-9} second have already been attained.

Herold cited circuit elements in which improvements in performance have been attained by means of inhomogeneous

structures. Among the examples mentioned were the graded base transistor, a specially designed transmission line, a high temperature inductor, and a sensitive loop antenna. The high temperature inductor (Fig. 8) features a ferrite core blended in such a way that the ferrite with maximum Curie temperature is located in the hottest region, within the coil, and the coolest region, remote from the coil, employs a ferrite with low Curie temperature but high permeability. Thus, the temperature and effective permeability are optimized. The sensitive antenna (Fig. 9) is wound around a composite ferrite rod. The central section, which is closely coupled to the coil, is composed principally of low loss ferrite, whereas the composition at the ends of the rod gives way to a ferrite with high permeability. Thus, the over-all sensitivity is maximized.

The conference closed with a lively discussion on the future course of solid-state electronics by a panel of experts.

B. R. Gossick

Motorola, Inc., Phoenix, Arizona

Forthcoming Events

January

27–28. Scintillation Counter Symp., Washington, D.C. (G. A. Morton, Radio Corporation of America, Princeton, N.J.)

27–29. American Soc. of Heating and Air-Conditioning Engineers, Pittsburgh, Pa. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

27–30. American Meteorological Soc., 163rd natl., New York. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

27–31. Institute of Aeronautical Sciences, 26th annual, New York, N. Y. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

28–30. Aging, 4th Ciba Foundation Colloquium (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–30. American Mathematical Soc., 64th annual, Cincinnati, Ohio. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

29–31. American Astronomical Soc., 4th annual, New York. (A. B. Crunden, AAS, 516 Fifth Ave., New York 36.)

29–'. American Physical Soc., annual, New York, N.Y. (K. K. Darrow, Columbia Univ., New York 27.)

30–31. College–Industry Conf., American Soc. for Engineering Education, 10th annual, Ann Arbor, Mich. (W. D. McIlvaine, College of Engineering, Ann Arbor.)

30–31. Mathematical Assoc. of America, annual, Cincinnati, Ohio. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

30–1. American Assoc. of Physics Teachers, New York. (F. Verbrugge, Univ. of Minnesota, Minneapolis.)

30–1. Western Soc. for Clinical Research, 11th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, Univ. of Oregon Medical School, Portland 1.)

31–1. Problems of Geriatrics, symp. (by invitation only), New York. (B. F. Chow, Johns Hopkins Univ., School of Hygiene and Public Health, 615 N. Wolfe St., Baltimore 5, Md.)

February

1–14. Pan American Assoc. of Ophthalmology, Caribbean cruise cong., sailing from New York, N.Y. (L. V. Arnold, 33 Washington Sq. W., New York 11.)

3–4. Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Del. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

3–7. American Inst. of Electrical Engineers, winter genl., New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

5–7. Biophysical Soc., Cambridge, Mass. (A. K. Solomon, Biophysical Lab., Harvard Medical School, Boston, Mass.)

10–14. American Soc. for Testing Materials, St. Louis, Mo. (F. F. Van Atta, ASTM, 1916 Race St., Philadelphia 3, Pa.)

13–15. National Soc. of Professional Engineers, spring, East Lansing, Mich. (NSPE, 2029 K St., NW, Washington 6.)

16–20. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

20–21. Transistor and Solid State Circuits Conf., Philadelphia, Pa. (J. H. Milligan, Jr., Dept. of Electrical Engr., New York Univ., New York 53.)

22–25. American Educational Research Assoc., St. Louis, Mo. (F. W. Hubbard, AERA, 1201 16th St., NW, Washington 6.)

24–28. American Soc. of Civil Engineers, Chicago, Ill. (W. W. Wisely, ASCE, 33 W. 39 St., New York 18.)

March

1. Junior Solar Symposium, Tempe, Ariz. (Association for Applied Solar Energy, 3424 N. Central Ave., Phoenix, Ariz.)

1–3. National Wildlife Federation, St. Louis, Mo. (E. F. Swift, NWF, 232 Carroll St., NW, Washington 12.)

3. Wildlife Soc., annual, St. Louis, Mo. (D. L. Leedy, U.S. Fish and Wildlife Service, Washington 25.)

5–6. Gas Conditioning Conf., 7th annual, Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

6–8. Fundamental Cancer Research, 12th annual, Houston, Tex. (W. K. Sinclair, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 25.)

6–8. Optical Soc. of America, annual, New York. (A. C. Hardy, Massachusetts Inst. of Technology, Cambridge 39.)

10–13. American Assoc. of Petroleum Geologists, annual, Los Angeles, Calif. (R. H. Dott, AAPG, Box 979, Tulsa 1, Okla.)

10–13. Society of Economic Paleontologists and Mineralogists, annual, Los Angeles, Calif. (R. H. Dott, Box 979, Tulsa, Okla.)

16–21. Nuclear Engineering and Science Cong., Chicago, Ill. (D. I. Cooper, *Nucleonics*, 330 W. 42 St., New York.)

17–21. National Assoc. of Corrosion Engineers, 14th annual, San Francisco, Calif. (NACE, Southern Standard Bldg., Houston 2, Tex.)

18–20. Amino Acids and Peptides, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

20–22. Michigan Acad. of Science, Arts and Letters, annual, Ann Arbor. (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

20–22. Pulmonary Circulation Conf., Chicago, Ill. (Wright Adams, Chicago Heart Assoc., 69 W. Washington St., Chicago 2.)

20–23. International Assoc. for Dental Research, annual, Detroit, Mich. (D. Y. Burrill, Univ. of Louisville, School of Dentistry, 129 E. Broadway, Louisville 2, Ky.)

23–26. American Assoc. of Dental Schools, annual, Detroit, Mich. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

23–29. American Soc. of Photogrammetry, 24th annual, jointly with American Cong. on Surveying and Mapping, 18th annual, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

24–27. Institute of Radio Engineers, natl. conv., New York. (G. W. Bailey, IRE, 1 E. 79 St., New York 21.)

27–29. National Science Teachers Assoc., 6th natl., Denver, Colo. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

29. South Carolina Acad. of Science, annual, Charleston. (Miss M. Hess, Dept. of Biology, Winthrop College, Clemson, S.C.)

29–30. American Psychosomatic Soc., 15th annual, Cincinnati, Ohio. (T. Lidz, 551 Madison Ave., New York 22.)

30–3. American College Personnel Assoc., annual, St. Louis, Mo. (L. Riggs, DePauw Univ., Greencastle, Ind.)

April

1–3. Corrosion Control, 5th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

2–4. American Assoc. of Anatomists, annual, Buffalo, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

2–4. Instruments and Regulators Conf., Newark, Del. (W. E. Vannah, Control Engineering, 330 W. 42 St., New York 36.)

4–5. Southern Soc. for Philosophy and Psychology, annual, Nashville, Tenn. (W. B. Webb, U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

7–11. American Assoc. of Cereal Chemists, annual, Cincinnati, Ohio. (J. W. Pence, Western Utilization Research Laboratories, Albany, Calif.)

8–10. Electronic Waveguides Symp., New York. (J. Fox, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

9–12. National Council of Teachers of Mathematics, Cleveland, Ohio. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

(See issue of 20 December for comprehensive list)

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ LIQUID-LEVEL GAGE, for use when no escape of liquid or vapor can be tolerated, indicates by means of a magnetically actuated scale. The gaging mechanism is contained in a stainless-steel chamber. The scale consists of a series of edge-magnetized wafers, one side finished in red, the other in silver. Changes in level operate a float which magnetically turns the wafers over. The boundary between the red and the silver wafers indicates the liquid level. (Jerguson Gage and Valve Co., Dept. S803)

■ BATTERY, 1¼ in. long by ⅜ in. in diameter, furnishes 95 v. A steady current of 10^{-9} amp can be supplied for 176,000 hr at 70°F with 10 percent voltage drop. Flash current of 20 μa can be obtained. Shelf life is greater than 20 yr. (Universal Winding Co., Dept. S823)

■ AUTOMATIC CHECK-WEIGHING MACHINES are available in capacities from 1 g to 100 lb. Accuracies from 1 part in 5000 to 1 part in 20,000 are attainable. Automatic transfer mechanisms place items on, and remove them from, the weighing element. The actual weight of the object is indicated visually on a scale. An optical control system consisting of crystal photocells on adjustable mountings alongside the scale check the weight against preselected limits. Weighing rates from 30 to 120 per minute are available. (Exact Weight Scale Co., Dept. S821)

■ CONTACT-MAKING METERS combine panel indicating instruments with thyratron relay control units. The instruments conform to ASA specifications for portable secondary standards. Contact make or break value is continuously variable and is accurate to 0.25 percent. The relay is rated at 5 amp, 115 v, a-c noninductive. Response time varies with application from a few milliseconds to 2 sec full scale. (Sensitive Research Instrument Corp., Dept. S822)

■ CRYSTAL OVEN uses the latent heat of fusion of crystalline materials to provide constant temperatures. At 24°C ambient, cavity temperature is 70.6°C. Temperature control is within ±0.5° from −20° to +50°C ambient and approximates ±0.005°C at fixed ambient. Input voltage is 5 v a-c or d-c, regulated to ±2 percent. (Robertshaw Fulton Controls Co., Dept. S807)

■ HYDROGEN DISCHARGE TUBE furnishes high-intensity hydrogen Balmer lines. The gas atmosphere within the lamp is water vapor, which furnishes hydrogen atoms and ions. Molecular hydrogen formed during the discharge, which would produce a background, continuous spectrum, is continuously purged and converted to water vapor by a cartridge inside the electrodes. The lamp, which is constructed of Vycor and Pyrex glass, operates continuously at powers up to 75 w. (Robert K. Hassler Co., Dept. S827)

■ AIRBORNE FLASH LAMP provides high-intensity light for tracking missiles, target planes, or balloons. The light consists of a photoflash lamp assembly and a pulsing circuit. Flash repetition rate is 2 to 3 flashes per second. Ambient temperature range is −55° to +130°F. Operation is on 28, 14, or 7 v d-c; the power requirement is 50 w. (Research Inc., Dept. S809)

■ STRIP CAMERA will photograph on a continuous strip of film such objects as oil-field and mining cores, log charts, and strip charts. The camera loads with 60 ft of color or black-and-white 70-mm film. The subject may be 12 ft long and 2.25 in. wide. Exposure is made at the rate of 3 in./sec. Focus is automatically maintained. (Bill Jack Scientific Instrument Co., Dept. S814)

■ MICROTOME permits the operator to cut ultrathin and thick sections alternately, for use in electron and light microscope comparisons. Sections 0.025 μ thick can be obtained. A tissue-thickness selector permits the operator to adjust to thicknesses from 0.025 to 0.5 μ. Ivan Sorvall Inc., Dept. S824)

■ INERTIA SWITCH is actuated by thrusts, impacts, or excessive vibration. Once actuated, the switch will remain open until it is reset manually. Thrust duration of 1/30 sec or greater is required to open the switch. Factory settings from 1.5 to 10 g can be supplied. (Minneapolis-Honeywell Regulator Co., Dept. S825)

■ CULTURE APPARATUS provides a constant flow of nutrient liquids used to maintain a microorganism population of constant conditions. The apparatus can be furnished with a glass feeder and growth tube or as a complete assembly. (Delmar Scientific Laboratories, Dept. S828)

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PERSONNEL PLACEMENT

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POSITIONS WANTED

Ecologist, general and physiological; vertebrate zoology. Ph.D.; age 47; professor of zoology. Publications. Desires change in academic position, teaching, and research. Box 325, SCIENCE. 1/10

General Physiologist; Ph.D.; age 32. Experienced in algal physiology, biochemistry, metabolic and enzyme methodology, microchemical analysis. Interested in research or research and teaching position. Box 321, SCIENCE. 1/3

Microbiologist, Ph.D.; experience also in metabolism. Academic, bacteriology or others; academic or industrial research. Box 308, SCIENCE. 12/13, 20, 27

Microbiologist, Ph.D.; 6 years' experience teaching and research. Desires academic position. Box 323, SCIENCE. X

Physicist, Ph.D.; 10 years' teaching physics, mathematics, including 4 years as professor of physics, large university; 5 years, physicist-statistician (statistical aspects of guided missile research), university research laboratory. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

Zoologist, Ph.D.; 1-year postdoctoral research; 6 years' teaching experience; ornithology, mammalogy, wildlife management, ecology; publications; excellent teacher. Desires research and teaching position. Box 322, SCIENCE. 1/3

POSITIONS OPEN

(a) **Bacteriologist;** M.S., Ph.D. to head department, very large general facility; to $8400; 1-month vacation, time for attendance at professional meetings; midwestern industrial city. (b) **Research Biochemist;** young Ph.D. interested, experienced enzyme chemistry, research and faculty appointment, midwestern university medical school; present project microchemical analysis biological fluids; to $7000. (c) **Biochemist;** Ph.D. and (d) **Bacteriologist;** M.S., Ph.D. experienced hospital laboratory; head respective sections, 400-bed general hospital; college city; Mid-East. (e) **Pharmacologist;** direct research, development staff of eight Ph.D.'s; basic, clinical, market research; important pharmaceutical company; Midwest. Woodward Medical Bureau, Ann Woodward, Director, 185 N. Wabash Avenue, Chicago. X

Chemist, male, with B.S. or M.S. degree in organic chemistry, to participate in analytical biochemical research in mental illness in hospital near Philadelphia. Write stating age, education, experience, and salary desired to P.O. Box 8507, Philadelphia 1, Pa. 12/20, 27; 1/3, 10

CHEMISTS AND MATHEMATICIANS; Ph.D. preferred; teaching and research in expanding departments; salary dependent on experience and other qualifications. Inquiries should be addressed to Chairman, Division of the Natural Sciences, Dillard University, New Orleans 22, Louisiana. 12/20, 27; 1/3, 10, 17

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Send complete résumé to Personnel Manager, General Offices, Falstaff Brewing Corporation, 5050 Oakland Avenue, St. Louis 10, Missouri. 1/3

(a) **Biochemist and Microbiologist** qualified to assume responsibilities; preferably Ph.D. but candidates with master's degree eligible; 600-bed teaching hospital. (b) **Anatomist** experienced in gross anatomy and, also, **Anatomist** qualified in electron microscopy; university medical school; 12-month salary status; month vacation; no summer teaching; South. (c) **Senior Toxicologist;** master's in biochemistry or pharmacology with some toxicological training; excellently equipped laboratories for scientific investigations; Southerner preferred. (d) **Clinical Bacteriologist and Biochemist;** 500-bed general hospital; expanding department; receptive medical staff; college town near university city; Midwest. (e) **Biochemist,** Ph.D., association, well-established pathologist, director of pathology, new general hospital, California. S12-4, Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

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Write stating qualifications and salary desired to:

Wyeth
Box 8299
Philadelphia 1, Pa.

Biological Scientist. Leading eastern pharmaceutical manufacturer desires scientist to participate in analysis and evaluation of technical data. Background should include M.S. in one of the biological disciplines or equivalent industrial or research experience. Send complete résumé. Box 324, SCIENCE. X

Microbiologist. Ph.D., recent graduate with experience or training in tissue culture and virology. Responsible research position with rapidly expanding veterinary biological and pharmaceutical manufacturer located in Midwest. Fine working conditions, liberal employee benefits, including a profit-sharing program, and excellent opportunity for advancement. Please send complete résumé, including approximate salary requirements, references, and date available in first letter. Our employees know of this ad and all inquiries will be held in strict confidence. Box 306, SCIENCE. 12/13, 20, 27

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POSITIONS OPEN

Physical or Photo Chemist needed by medical research foundation presently engaged i.. research work in biologics and ultraviolet. Will be trained to assist and aid in supervision of investigational programs. Excellent, unusual opportunity available. Box 315, SCIENCE.
12/27; 1/3, 10

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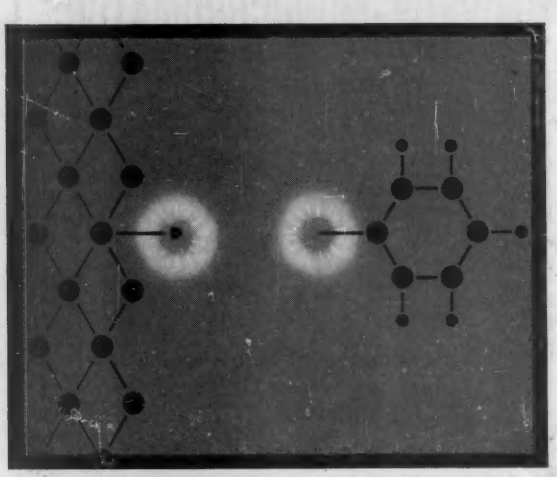

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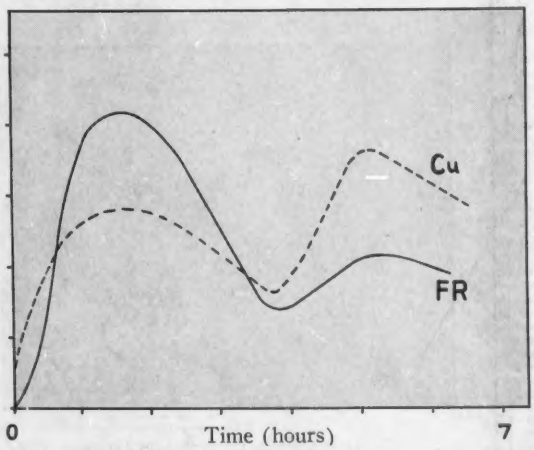
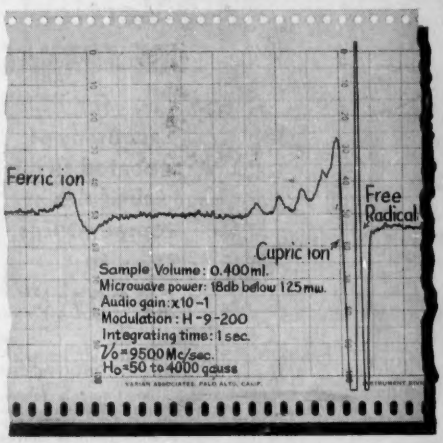
INTERPRETATION: Metallic ions play important roles in many enzyme-substrate reactions; in others they enter only as impurities. EPR is a unique tool for monitoring and distinguishing paramagnetic ions and free radicals. As in the previous example, the following spectrum was obtained from fatty acyl CoA dehydrogenase acting upon 20 microliters of octanoyl CoA substrate. The sample was frozen at 77°K to separate the ferric, cupric and free radical signals appearing left to right on the spectrum. The hyperfine structure on the cupric ion spectrum is due to the interaction with the nuclear magnetic moments of Cu^{63} and Cu^{65}. The graph reveals that the cupric ion follows approximately the same kinetics as the free radical despite the fact that copper is considered to be an impurity in this reaction. It is to be noted also that there is more than one competing free radical reaction. What relation any of this information has with the fundamental process of interest in nature remains to be seen.

This data was furnished by courtesy of Dr. H. E. Beinert, Institute for Enzyme Research, University of Wisconsin.





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